INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

YGL BULLETIN NO. 5

DECEMBER 1972

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UNITED STATES

DEPARTMENT OF COMMERCE

DEPARTMENT OF DEFENSE

DEPARTMENT OF INTERIOR

DEPARTMENT OF TRANSPORTATION

ENVIRONMENTAL PROTECTION AGENCY

NATIONAL SCIENCE FOUNDATION

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

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CANADA

ENVIRONMENT CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

ONTARIO MINISTRY OF THE ENVIRONMENT

ONTARIO MINISTRY OF NATURAL RESOURCES

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Editor's Note

Within the pages of this section of the Bulletin we are attempting to give an accurate, succinct, and up-to-date account of the IFYGL in Canada. Numbers 1 and 2 mostly dealt with our organisation and plans, and in Number 3 some of the equipment was described. Numbers 4 and 5 were the first issues to give preliminary results together with an account of how closely our ships and aircraft followed the plans. There are still gaps, any contributions which would help fill these gaps would be greatly appreciated.

J. MacDowall
Canada Centre for Inland Waters
Burlington, Ontario.

UNIVERSITY PARTICIPATION

Nine Canadian Universities were actively involved in IFYGL projects, from the University of British Columbia in the West to Dalhousie University in the East (see Table 1). The objectives of the programs were set out in this Bulletin and in Bulletin #2. Particularly prominent, in both planning and execution phases, were the Universities of Toronto and Waterloo.

In order to present this facet of IFYGL activity, the Management Team solicited a special account of their work from each University participant. Two such accounts were available for this Bulletin.

The University of Copenhagen, Denmark, were involved with a joint project with CCIW support (114WM).

Table 1. Canadian University Projects

University	IHD/IFYGL Project No.	Bulletin Reference
B.C.	106	2
Dalhousie	112	5
Guelph	70	2
Mc Master	51, 70, 71, 80	2
Queen's	54	2
Toronto	32, 34, 36, 47, 109	2
Trent	49	2
Waterloo	40	5
Windsor	78	2

North-Shore Coastal Chain Study

The University of Waterloo, Environmental Fluid Mechanics Laboratory, has conducted the North Shore "coastal chain" studies during IFYGL, under contract with CCIW, Burlington. The objective of the work was to gain a descriptive account of "coastal boundary layer" in Lake Ontario, i.e. the current velocity distribution within about 12 km from shore and its relationship in the density structure of the water and to atmospheric variables. Observations were collected during three "alert" periods, May 15 to June 15, July 15 to August 15, and September 15 to October 15. Measurements were taken using a

current meter attached to the side of a 28' aluminium pontoon boat (see Figures 1 and 2).

A good set of data were obtained in all three periods, gaps due to bad weather or other causes having been minimal. While it is expected that full data analysis will take some considerable time, some preliminary results of the spring alert period (May 15 - June 15) tell the following story.

A persistent spring thermocline existed from the start of observations to about June 10. At Oshawa, the history of this period was simpler than at Presqu'ile, currents at the latter locations being quite evidently influenced by complex local topography. Flow was westward at Oshawa from May 10 to May 31, and the spring thermocline was of the "wedge" shape. After June 1, flow was eastward and the thermocline was "lens" shaped. Maximum velocities in either kind of flow ranged from 10 to 30 cm/s. Significant motion was confined to the warm band and its immediate vicinity.

There was good evidence of vertical momentum transfer across the thermocline to the deeper layers by a mechanism not involving mixing of fluid (presumably by internal waves). One clear instance of significant mixing occurred during a cold outbreak and was associated with cooling from above. At the end of the observation period strong winds broke down the spring thermocline and a weak summer thermocline became established.

Winds measured by the pontoon-boat's anemometer varied strongly with distance from shore and correlated well with surface water temperatures, with negligible winds often occurring over the cold water outside the thermal front where the spring thermocline came to the surface. The warm band enclosed within the wedge-shaped spring thermocline in the earlier half of the alert period exhibited some clear instances of geostrophic adjustment to wind-stress impulses. It is already clear that it will be essential to take into account these wind stress impulses as well as (non turbulent) friction across the thermocline in order to understand the behaviour of the spring thermocline and associated coastal jets.

The exact location of the observation stations is given in Tables 2 and 3.

Figure 1. Pontoon boat used in current measurements during coastal chain studies.

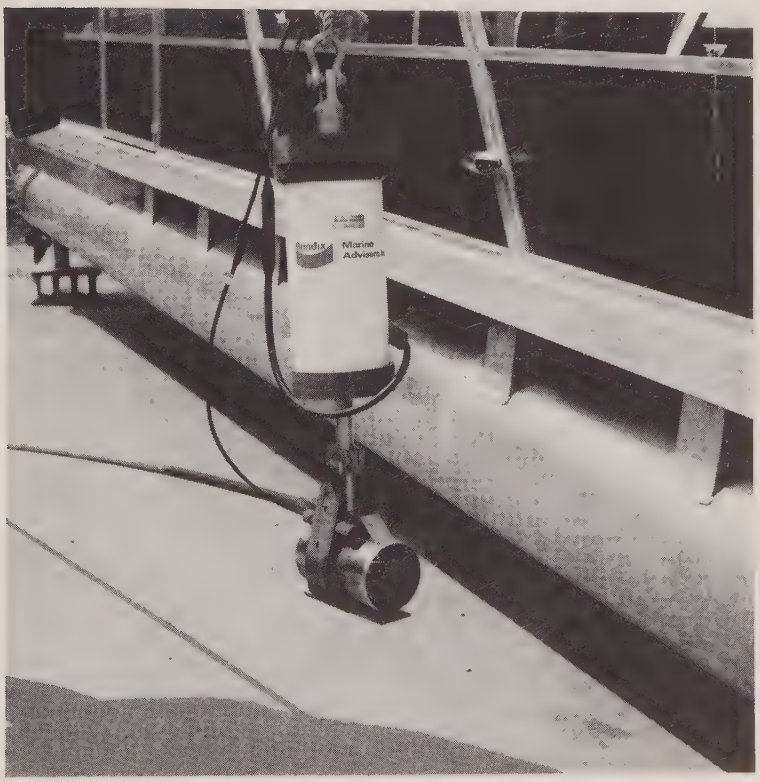

Figure 2. A close-up of current meter used during coastal chain studies.

Table 2. COASTAL CHAIN - OSHAWA

No.	Depth (m)	Latitude N.	Longitude W.	Distance from Deep Water Buoy #6 (km)
1	10.9	43° 51.08'	78° 49.91'	13
2	18.3	43° 50.53'	78° 49.84'	12
3	23.5	43° 49.98'	78° 49.77'	11
4	27	43° 49.45'	78° 49.70'	10
5	36	43° 48.90'	78° 49.64'	9
6	41.5	43° 48.35'	78° 49.58'	8
7	45	43° 47.80'	78° 49.51'	7
8	54	43° 47.25'	78° 49.45'	6
9	57	43° 46.72'	78° 49.37'	5
10	61	43° 46.17'	78° 49.29'	4
11	74	43° 45.09'	78° 49.16'	2
(6)12	81	43° 44.00'	78° 49.00'	0

Table 3. COASTAL CHAIN - PRESQU'ILE

No.	Depth (m)	Latitude N.	Longitude W.	Distance from Deep Water Buoy #9 (km)
1	10.9	43° 59.30'	77° 40.52'	17
2	11.7	43° 58.21'	77° 40.57'	15
3	21.6	43° 57.13'	77° 40.62'	13
4	29	43° 56.05'	77° 40.67'	11
5	36	43° 55.48'	77° 40.70'	10
6	38	43° 54.92'	77° 40.74'	9
7	38	43° 54.35'	77° 40.76'	8
8	39.5	43° 53.80'	77° 40.78'	7
9	43	43° 53.23'	77° 40.80'	6
10	54	43° 52.14'	77° 40.85'	4
11	63	43° 51.08'	77° 40.91'	2
(9)12	67	43° 50.00'	77° 41.00'	0

G. T. Csanady

Snow Stratigraphy and Distribution

The following publications have been produced as part of the snow measurement program:

Matheson, S. A. 1972. Snow distribution; melt and run-off characteristics of an inter-drumlin swale (Peterborough) B.Sc., Honours Thesis, Trent University.

Matheson, S. A. 1972. Snow distribution; melt and run-off characteristics of an inter-drumlin swale (Peterborough), Trent Student Geographer, 1, 43 (resume of Honours Thesis).

Abstract

The solution of water resources problems ultimately requires accurate measurements of available run-off as an aid to their solution. The regionalization of water problems, based on available run-off, is briefly discussed. The characteristics of snow distribution, melt and run-off are investigated for a representative catchment in a proposed water sub-region, the Peterborough Drumlin Field. From data collected on a grid snow course within an inter-drumlin swale, maps of snow distribution were produced and predominant distribution factors were isolated. The snow melt and run-off characteristics of the catchment were investigated and the usefulness of generalized melt equations is discussed against melt data from standard snow course melt measurements and discharge figures. Basic characteristics of the inter-drumlin wetland storage, flow and lag are revealed.

W. P. Adams

AIRBORNE MEASUREMENT OF SNOW WATER EQUIVALENT BY NATURAL GAMMA RADIATION

Introduction

In most areas of Canada streamflow reaches a maximum during the spring melt period, and forecasts are required for flood hazards, the operation of storage reservoirs and other streamflow regulation activities. These forecasts are based primarily on anticipated weather conditions and snowpack observations. At present the total storage of water in the snowpack over a basin has to be estimated from a limited number of point measurements. Studies in the Great Lakes Basin have shown that improved estimates of basin snowpack water storage offer the best immediate prospect for improved hydrological forecasting and water resource management during the critical freshet period. Improvements in weather forecasts are slow to evolve. Remote sensing methods show considerable promise in this regard, since they can provide spatially-continuous observational data on snowpacks over large areas.

Dmitriev et al. (1971) report that the airborne gamma method is used operationally for snow surveying in the U.S.S.R. Research has also been carried out in Norway (Dahl and Ødegaard 1970) and in the USA (Peck et al. 1971). In Canada, Grasty and Holman (1972) recently reported results obtained with the airborne gamma-ray spectrometer of the Geological Survey of Canada. The spectrometer is used in summer for the purpose of mapping surface concentrations of potassium, uranium, and thorium from the air. In the winter, the survey work is discontinued owing to the gamma radiation attenuation effect of the snowpack water.

Soil Moisture Sampling

The source of gamma-rays measured by a detector near the ground originates primarily from radio-active isotopes in the soil. Zotimov reported that for a typical soil, 91% emanated from the top 10 cm, 5% from 10-20 cm depth, and 3% from 20 - 30 cm. Soil moisture in the top row of the soil has considerable influence on the counts received by a detector, due to absorption of gamma-rays. Soil moisture measurements should therefore be carried out along the flightline to a depth of 15 cm (6 inches) to correct the observed count rate to a selected base soil moisture index.

The sampling scheme is designed to obtain a representative sample of soil moisture over the snowcourse or test line. Care should be taken to sample different vegetation environments, i.e. fallow, pasture, forest, bush, etc., in proportion to their actual occurrence along the snowcourse. Three samples is the minimum for each vegetation class. So, if a snowcourse has three distinct different vegetations, the minimum number of samples is 3 times 3 = 9 soil moisture samples. The same rule applies also to terrain features; a proportional number of samples would be taken in high and low areas.

Where new locations for snow and soil moisture measurements will be established, the following should also be taken into consideration; The shortest time interval gamma count rates will be recorded for all 4 windows is 2.5 seconds. This compares with approximately 450 feet on the ground. However, the statistics of the countrate determines the shortest distance over which any meaningful comparison with ground-truth data can be done. The minimum would likely be 1 mile. After the first survey, more information will be available on the natural radiation pattern.

Sampling Procedure

A soil sampling kit (Oakfield kit) containing a sampling tube (open on one side), a screw-type auger and two 1 ft. extensions, will be used, together with 12 aluminum boxes. Preferably the soil tube will be used because it disturbs the soil matrix the least. The probe is held vertical and pushed evenly into the soil to a depth of 6 inches. If the soil is very hard or frozen, the auger attachment will be used. The auger is screwed into the soil, again to a depth of 6 inches, through a small hole in a plastic sheet. While screwing, the auger will deposit soil on the plastic. After the required depth is reached, take the auger out and put the remaining soil on the screw onto the plastic sheet. If the soil is frozen so hard that even an auger will not do the job, an ordinary pick or light shovel will be tried to remove top 6".

Flight Plan

In order to facilitate flight path recovery and pilot navigation (over 90, 1:50,000 maps are involved) the route was split into individual flight lines each of which was a straight line covering at least 2 snow courses. The snow courses covered are generally of the order of 1000 ft. in length and as the areal technique will average over distances of from 2 to 5 miles, depending on the ground radioactivity, the flight track is designed to pass over the middle of the snow courses. No attempt will be made to fly in the direction of the snow course unless this happens to be the flight line direction. Figure 3 gives details of the flight route covered.

Equipment

The survey will be carried out at a mean elevation of 500 feet, at a mean air speed of 120 m.p.h. Twelve, 9 x 4 inch NaI (TI) detectors will be used, each of which is temperature stabilized. Flight track recovery will be carried out in the aircraft by the equipment operator using a T.V. monitor and camera mounted in the nose of the aircraft. As a back-up, T.V. video tape recording will also be employed together with a long-track Doppler navigation system. A radar altimeter will be used to monitor the height of the aircraft above ground. Total count information (0.4 to 2.8 MeV) will be

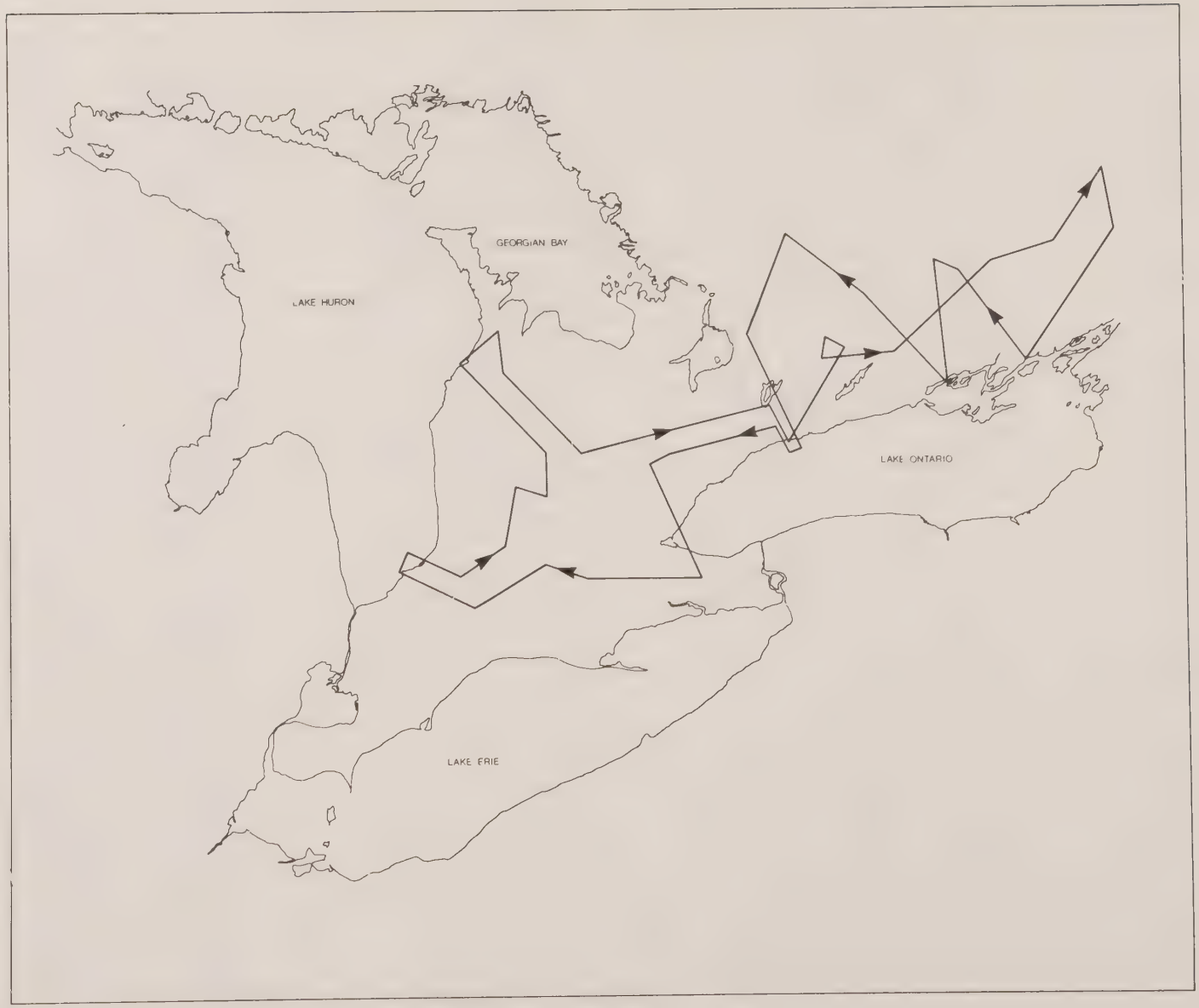

Figure 3. Flight path of airplane over gamma-ray survey snow courses.

recorded every 0.5s and thorium (2.4 to 2.8 MeV), uranium (1.65 to 1.85 MeV) and potassium (1.4 to 1.6 MeV) every 2.5s. The Doppler, altimeter, and radiation information, plus operator controlled information of line number, time, date, temperature, etc. will be recorded onto an incremental magnetic tape recorder.

Compilation

Results from the total count, thorium, and potassium measurements will be used to compute the water-equivalent snow depth. All radiation measurements will be corrected for air density, height, and Compton scattering in the detectors. Background corrections due to variations in the radon-222 concentrations in the air will also be applied, using measurements over the nearest body of water. Computer plotted profiles of the three corrected radiation measurements will be drawn for all flights. It is anticipated that 10 soil moisture sites will be selected from the snow courses covered and will be used to correct the snow survey results due to the water content in the soil. From a comparison of the pre-snow flight to the snow flight, a depth profile will be computer plotted for each of the three radiation measurements. Due to the statistical nature of the gamma radiation, it will not be possible to have a snow-depth calculation every recording period of 2.5 s. The snow depth profile will be a running average over distances of from 2 to 5 miles depending on the count rate observed.

Flight Schedule

Six flights will be made approximately on the following dates:

Monday,	October 30th	-	Pre-snow
Wednesday,	November 15th	-	Pre-snow (?)
Tuesday,	January 2nd	-	Snow
Wednesday,	January 31st	-	Snow
Wednesday,	February 28th	-	Snow
Wednesday,	March 28th	-	Snow

References

Dmitriev, A. V. et al. 1971. - Aircraft gamma-ray survey of snow cover. Nordic Hydrology, 11, 47.

Dahl, J. B. and Odegaard, H. 1970. - Aerial measurements of water equivalent of snow deposits by means of natural radioactivity in the ground. Isotope Hydrology, IAEA, Vienna, Austria, 191.

Peck, E. L. et al. 1971. - Evaluation of snow water equivalent by airborne measurement of passive gamma radiation. Wat. Res. Research 7, 1151.

Grasty, R. L. and Holman, P. G. 1972.- The measurement of snow water equivalent using natural gamma radiation. Paper presented at First Canadian Symposium on Remote Sensing February 7 - 9, 1972, Ottawa.

ATMOSPHERIC ENVIRONMENT SERVICE INSTRUMENTATION

A key AES committment to IFYGL was to provide the core program with six automatic weather stations along the Lake Ontario shoreline and three automatic telemetering stations aboard Bedford Tower platforms in the lake. Instrument Branch undertook the provision of these stations in support of Lake and Marine applications unit of Central Services. The equipment was operational by July 1972, owing to unforeseen development problems.

An equipment development specification was evolved in 1969 by interaction between the design and development group and the users. A survey of commercially available equipment confirmed that internal design and development should be undertaken along the lines of the MDA (Modular Data Acquisition) concept already being pursued in Instrument Branch. Although the Hydromet Projects Support group managed the design, development and procurement of the equipment, almost every group in Instrument Branch contributed to the project which involved sensor and electronics design as well as logistics design.

Each shoreline station samples atmospheric pressure, air temperature, dew point, precipitation and wind every ten minutes and records the data along with date and time on eight level punched paper tape. At some stations the Canada Centre for Inland Waters provides water temperatures for the record.

Each lake tower station samples three levels of air temperature, dew point and wind and single levels of precipitation and surface water temperature. The data is telemetered to the nearby shore pickups where it is recorded along with date and time on eight level punched paper tape. The lake tower stations are powered by lead-acid automotive batteries which are periodically recharged using a propane powered generator.

The lake tower station and its mooring system are depicted in Figure 4 The free-standing, fifty-foot, fibreglass-reinforced epoxy mast sports large mounting clamps to which the electronic boxes and sensor boon arms are attached.

The two lake tower stations located on the Canadian side of the lake are also equipped with autographic radiation recorders.

Several new sensors were utilized in this project. Among them were a miniature dewcel, a dual propeller wind component sensor and a vector pluviometer type dual receiver for the lake tower rain gauge to obviate wind effects. The volumetric rain gauge module is used throughout the system. Most of the other sensors were commercially available or adapted therefrom.

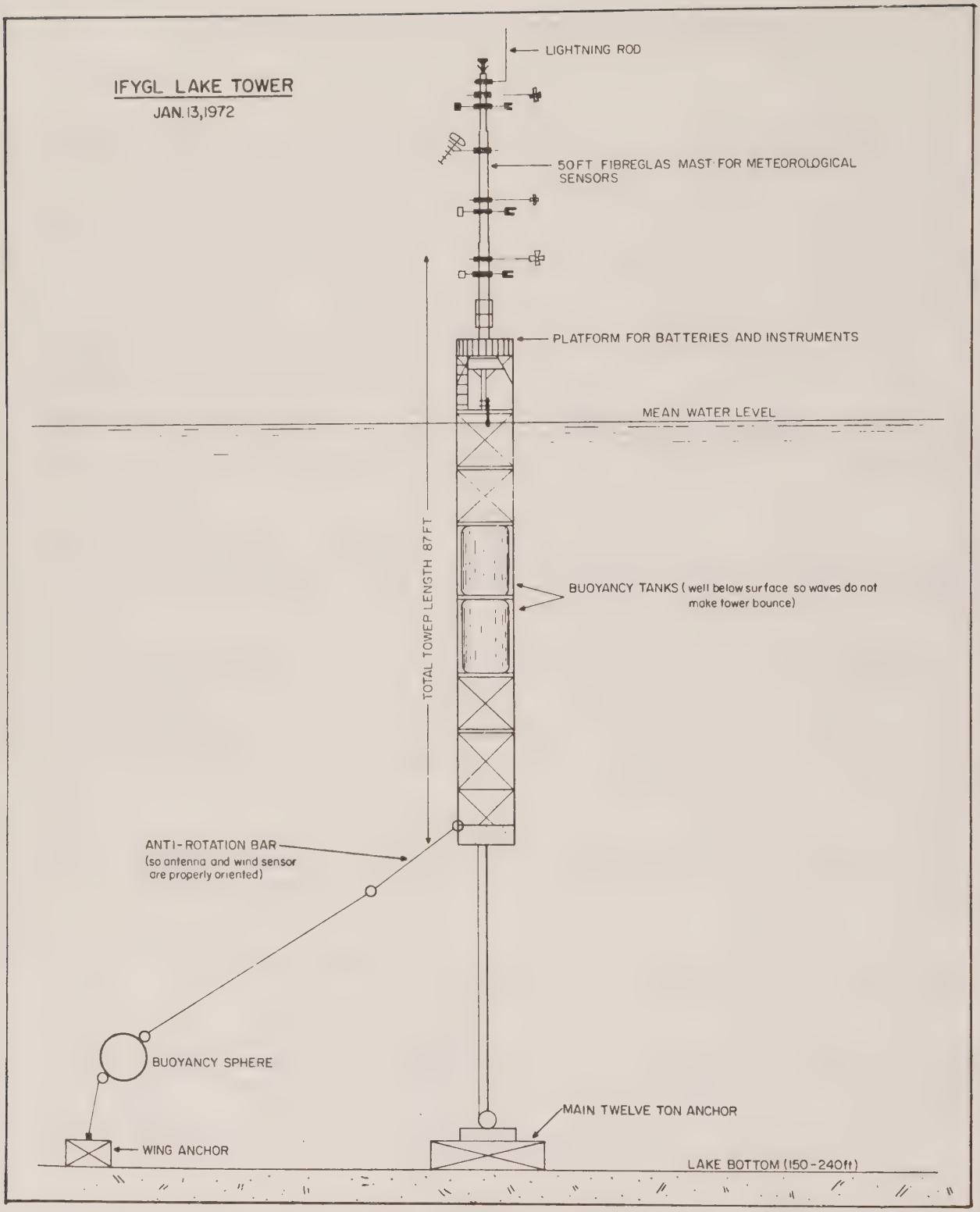

Figure 4. Lake tower station and mooring system.

CHLOROPHYLL a IN THE SURFACE WATERS OF LAKE ONTARIO

The observations made on eight occasions have been analyzed; a summary of the data is given in Table 4. A complete file of this data is available on request from the IFYGL Data Bank.

Table 4. Surface chlorophyll a data summary (uncorrected)

Date (1972)	Chlorophyll a (mg/m^3)		
	Mean	Maximum	Minimum
April 4 - 8	3.9	10.9	1.7
April 10-12	2.9	8.2	1.0
April 17-19	3.1	8.5	0.9
April 24-26	3.4	10.2	1.2
May 1 - 4	3.8	10.9	1.2
May 8 -11	4.8	15.4	1.1
June 5 - 9[1]	5.6	10.9	1.3
October 3 - 5	8.2	13.1	2.7

[1] 50% of stations only; U.S. vessel did the other half.

H. F. Nicholson

PRELIMINARY FISH STOCK DATA OBTAINED BY R.V. KEENOSAY

Introduction

The Canadian half of the fish program was undertaken by the Ontario Ministry of Natural Resources (OMNR) and utilized Units located at Picton, Wheatley, Maple and Richmond Hill. The Keenosay worked out of the Lake Erie Fisheries Station, Wheatley, Ontario. (See Bulletin 3, p.34) This preliminary data will probably require further interpretation and clarification.

The objective of this work was to investigate the qualitative and quantitative aspects and obtain other biological information on growth, stomach contents etc. on the fish populations in three selected areas in the north-west portion of Lake Ontario.

Methods, Gear and Procedures

The sampling sites chosen were located at Oakville, Whitby and Cobourg (Fig. 5). Relevant data on the sampling sites are given in Table 5 . Further data on dates and fishing locations is given in Table 6.

The principal gear used during the sampling periods were the following:

(a) Midwater trawl: 10 ft by 10 ft opening dimensions with codend of 1" mesh (stretched). A ½" liner was placed in codend.

(b) Gillnets: Graded mesh gillnet with various mesh sizes attached together randomly. Each gang of nets consisted of 30 yds. each of 1" to 2 3/4" mesh (incl.) by ¼" intervals and 50 yds. each of 3" to 5" mesh by ½" intervals.

(c) Plankton net for larval fish: Opening dimensions of approximately 5½ ft by 6½ ft. D shaped opening. Mesh size was 12 meshes per inch.

All fish catches were processed in the following manner:

(i) Total count and weight for each species in catch.
(ii) Twenty fish of each species collected for growth and sexual maturity per trawl haul or per gillnet mesh.
(iii) Whole fish preserved (10 per species per trawl haul or gillnet mesh when available) for stomach contents analysis.

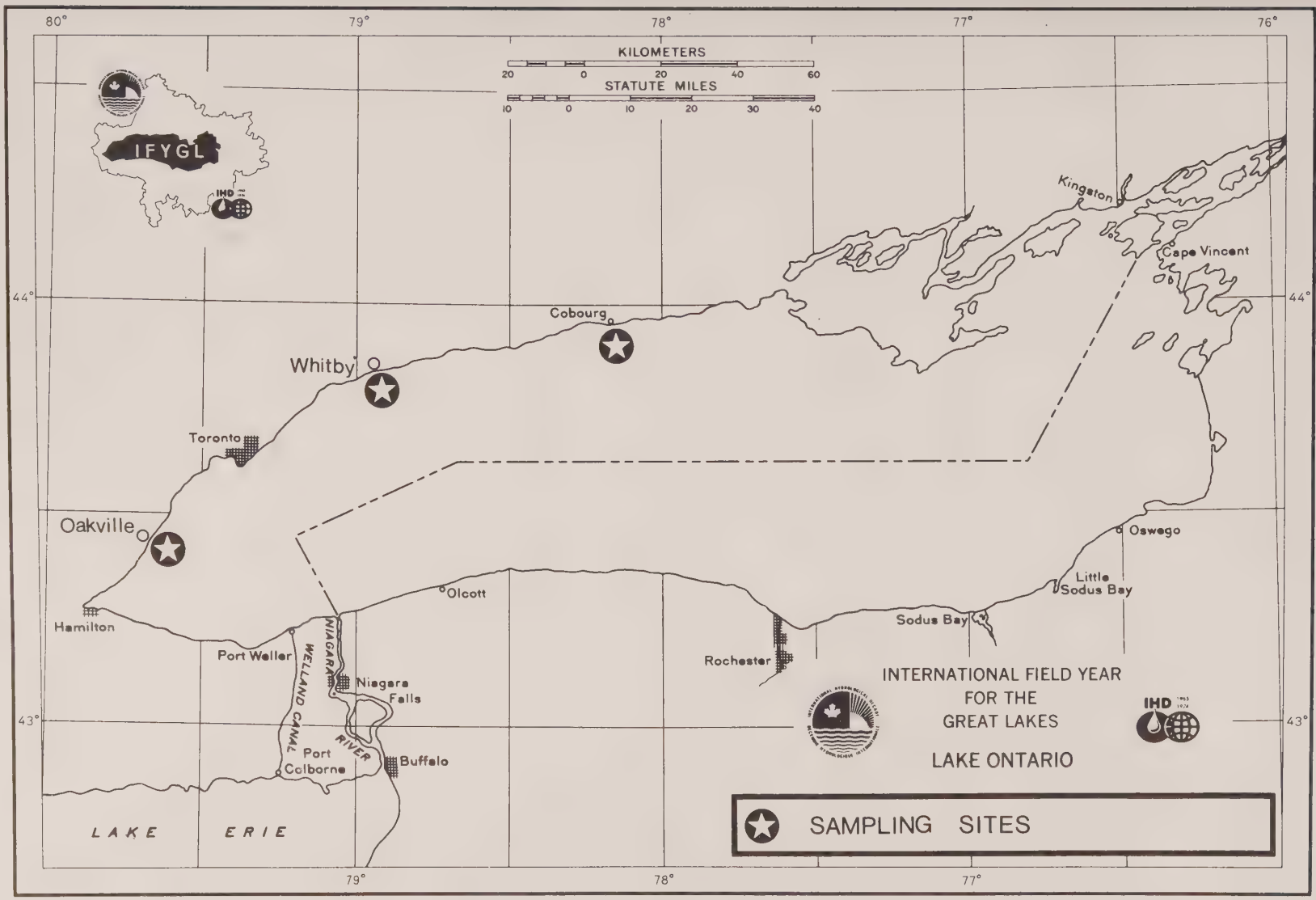

Figure 5. Fish survey sampling sites.

Speciments collected for growth, sexual maturity and stomach analysis were forwarded and stored at the Glenora Research Station, Picton, Ontario, for examination.

Results

The data presented in Table 7 are summary data on trawl and gillnet catches at the three locations where sampling was carried out. Data for 9 mesh sizes from 2 to 5 in. are available but omitted in Table 7 . Other samples are being held at Glenora for future detailed examination for growth, sexual maturity and stomach contents.

Two species lists are given: one by common names (Table 8) and another by the species family and order associations (Table 9).

Some trawling for larval fish was done in the vicinity of the sampling sites. Catches consisted mainly of young of the year alewife and smelt. Most abundant catches were off Cobourg where 10 minute tows at the surface resulted in young of the year alewife catches of 600-1200 larval fish.

Table 5. Data on the three sampling sites in Lake Ontario

Location	Bearings	Navigator Transects	Station Depth (ft)
Oakville	Lat. 43° 26' 4" Long. 79° 39' 5"	D0979 A3528	30
Whitby	Lat. 43° 56' 9" Long. 78° 10' 12"	I0340 A3159	30
Cobourg	Lat. 43° 56' 2" Long. 78° 17' 3"	B1725 A3432	30

Table 6. Cruise dates, locations fished and principal and secondary gear used by R.V. Keenosay during IFYGL operations on Lake Ontario.

Date	Location	Gear
June 6 - 8	Oakville-Whitby-Cobourg	Midwater trawl
June 14 - 22	Oakville-Whitby-Cobourg	Midwater trawl
Aug. 15 - 23	Oakville-Whitby-Cobourg	Midwater trawl and larval fish sampling
Aug. 28 - Sept. 1	Oakville	Graded mesh gillnet and larval fish sampling
	Port Credit	Graded mesh gillnet
Sept. 5 - 12	Oakville-Whitby-Cobourg	Graded mesh gillnet on bottom at all locations at depths of 15, 30, 60 and 120 feet - some midwater trawling.
Sept. 19 - 26	Oakville-Whitby-Cobourg	Graded mesh gillnet on bottom at all locations at depths of 15, 30, 60 and 120 feet - some midwater trawling.

Table 7. Total numbers of fish caught in bottom set gillnets of four mesh sizes off Oakville, Whitby, and Cobourg, Ontario, in 1972. All catches at 15, 30, 60 and 120 ft. contours combined.

LOCATION	OAKVILLE				WHITBY				COBOURG			
DATES	29 AUGUST - 21 SEPT.				8 - 24 SEPTEMBER				10 - 26 SEPTEMBER			
MESH (in)	1	1¼	1½	1 3/4	1	1¼	1½	1 3/4	1	1¼	1½	1 3/4
SPECIES												
Alewife	95	235	529	197	29	364	923	44	219	969	1388	172
Brown Bullhead	0	0	0	0	1	0	14	25	0	0	0	0
Carp	0	0	0	0	0	0	0	0	0	0	0	0
Coho Salmon	0	0	0	0	0	0	0	0	0	0	0	0
Gizzard Shad	0	0	0	0	0	0	0	0	0	0	0	0
Hog Sucker	0	0	0	0	0	0	0	0	0	0	0	0
Lake Chub	24	63	111	47	0	0	0	0	0	0	0	0
Log Perch	0	0	0	0	0	0	0	0	1	0	0	0
Longnose Dace	0	0	0	0	0	0	0	0	1	0	0	0
Northern Pike	0	0	0	0	0	0	0	0	0	0	0	0
Rock Bass	0	0	1	1	0	1	0	0	0	0	0	0
Round Whitefish	0	0	0	0	0	0	0	0	0	0	0	0
Sea Lamprey	0	0	0	0	0	0	0	0	1	0	0	0
Slimy Sculpin	8	15	4	0	3	1	1	0	1	1	0	0
Smallmouth Bass	0	0	0	0	0	0	0	0	0	0	0	0
Smelt	331	94	69	33	301	83	44	28	317	124	31	12
Spottail Shiner	4	1	0	1	37	0	0	0	46	3	1	0
White Bass	0	0	0	0	0	0	0	0	0	0	0	0
White Perch	0	0	1	1	0	0	0	2	0	1	0	5
White Sucker	0	1	8	8	0	1	3	10	3	1	3	7
Yellow Perch	0	0	0	0	3	7	26	16	0	0	2	1
Yards fished	330	330	330	330	240	240	240	240	210	210	210	210

Table 8. A species list (common names) of fish caught by R.V. Keenosay in Lake Ontario, 1972.

Alewife
Brown bullhead catfish
Carp
Coho salmon
Gizzard shad
Hog sucker
Lake chub
Logperch
Longnose dace
Northern pike
Rock bass
Round whitefish
Sea lamprey
Slimy sculpin
Smallmouth bass
Smelt
Spottail shiner
Threespine stickleback
White bass
White perch
White sucker
Yellow perch

Table 9. A species list (by Order and Family associations[1]) of fish caught by R.V. Keenosay in Lake Ontario, 1972

1. Order PETROMYZONTIFORMES
   - Petromyzontidae
     - Sea lamprey

2. Order CLUPEIFORMES
   - Clupeidae
     - Alewife
     - Gizzard shad

3. Order SILURIFORMES
   - Ictaluridae
     - Brown bullhead

4. Order CYPRINIFORMES
   - Cyprindae
     - Carp
     - Lake Chub
     - Longnose dace
     - Spottail shiner
   - Catostomidae
     - Hog sucker
     - White sucker

5. Order SALMONIFORMES
   - Salmonidae
     - Coho
     - Round Whitefish
   - Osmeridae
     - Rainbow smelt
   - Esocidae
     - Northern pike

6. Order PERCIFORMES
   - Percidae
     - Yellow perch
     - Logperch
   - Centrarchidae
     - Rock bass
     - Smallmouth bass
   - Cottidae
     - Slimy sculpin
   - Percichthyidae
     - White bass
     - White perch

7. Order GASTEROSTEIFORMES
   - Gasterosteidae
     - Threespine stickleback

[1]Classification according to "A List of Common and Scientific Names of Fishes from the United States and Canada". AFS Special Publication No. 6.

TEMPERATURE TRANSECTS OF LAKE ONTARIO, A PRELIMINARY ANALYSIS

Introduction

This cruise of the Limnos formed a portion of the program of the IFYGL Water Movements Panel. The experiment was one of a series designed to detect standing internal waves of lengths comparable with the Lake Basin dimensions. According to theory, these waves have periods close to the local inertial period, which is 17.5 hours for Lake Ontario. The waves were detected by the time and space changes in the temperature structure of the lake, as they deformed the isothermal surfaces in the region of the thermocline.

The experimental procedure consisted of collecting repeated temperature-depth profiles on a line across the lake from Oshawa, Ontario, to Olcott, New York, as shown in Figure 6 . A total of 21 crossings of the lake were made between 2255 GMT August 8 and 1410 GMT August 12, 1972. Each crossing took about 4 hours 10 minutes to complete. Temperature data was collected using two complementary systems, a Batfish undulating towed body carrying an EBT probe, and a towed thermistor array.

A similar survey of 23 crossings was undertaken from 10 to 14 July 1972, and a preliminary report was prepared. The final cruise of the series was undertaken on 2 - 6 October 1972.

Winds

The wind record at Burlington showed that from August 5 to August 8, 1972 winds were light and variable and were mainly local land-lake breezes. The average wind speed during this period is estimated to be 8 mph (4 m/s). From 0800 GMT (0400 EST) on 9 August to 0200 GMT on 10 August, a fresh westerly wind was recorded at Burlington with speeds reaching 20 mph (9 m/s). Thereafter the winds at Burlington blew steadily from the west (average speed $<$ 10 mph (5 m/s)), until the late afternoon of the 11th of August, when a second impulse from the south-west (peak hourly average of 15 mph (7 m/s)), was recorded. Thereafter, until the end of the cruise, winds at Burlington were again light and variable.

The winds measured aboard Limnos were plotted in Figure 7 , at a time scale directly comparable with the time series plots of thermal structure (Figure 8 a, b, c, d, e, f, g). The wind stress on the lake was dominated by a single strong impulse to the north-east centred on 1400 GMT 9 August, from south-westerly winds with peak speeds of 30 knots (13 m/s). The duration of the impulse was about 12 hours. This feature correlated with the impulse recorded at Burlington and an examination of the surface weather maps indicated that the wind was associated with the passage of a well developed low barometric pressure system through the region.

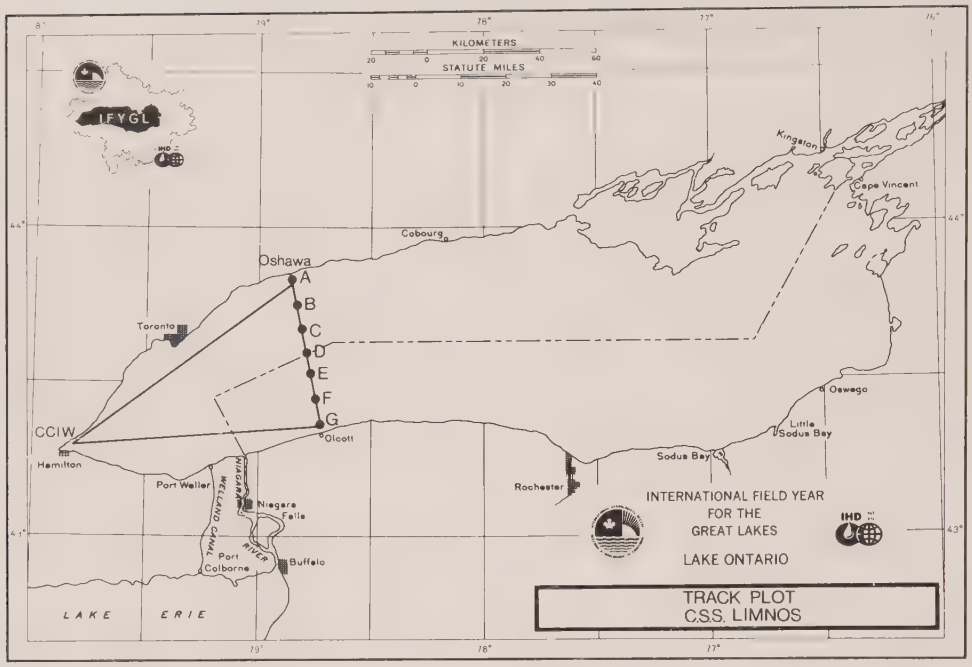

Figure 6. Track plot of CSS Limnos during August 8-10, Temperature Transect cruise.

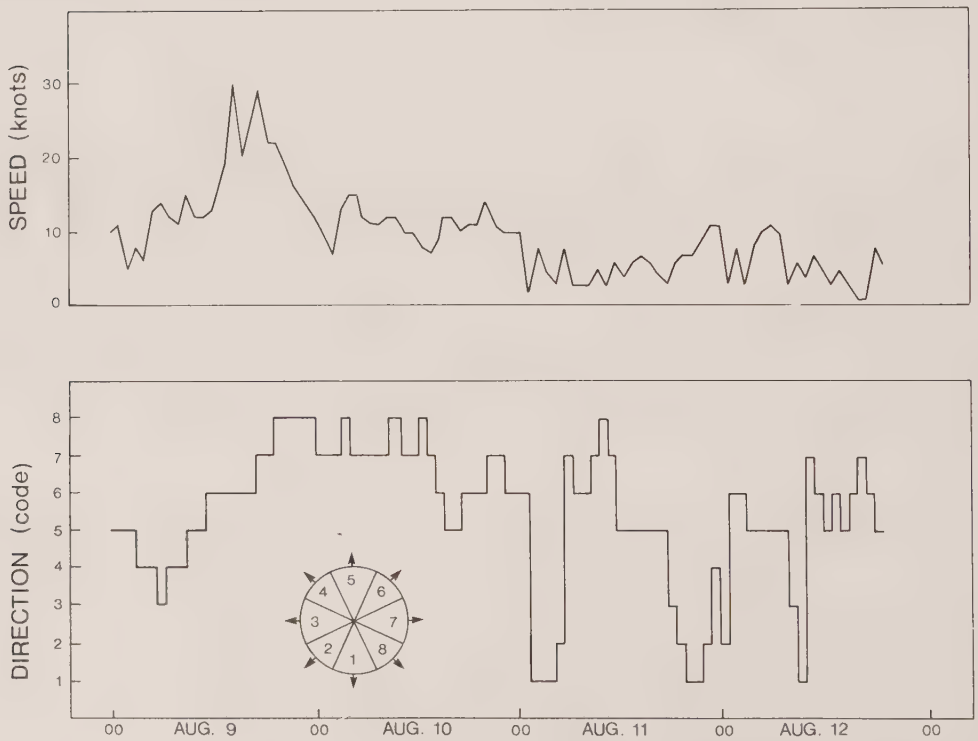

Figure 7. Plot of wind speed and direction during experiment.

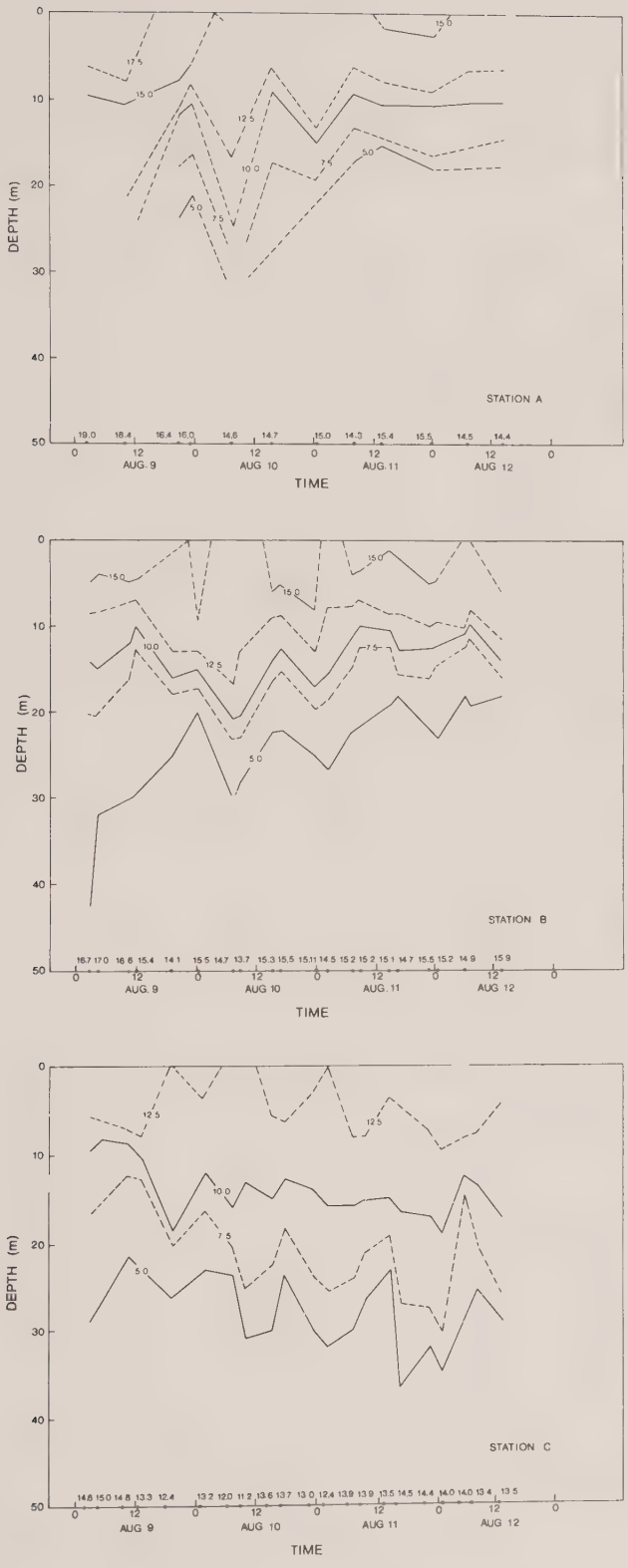

Figure 8. Time series plot of thermal structure at the seven stations.

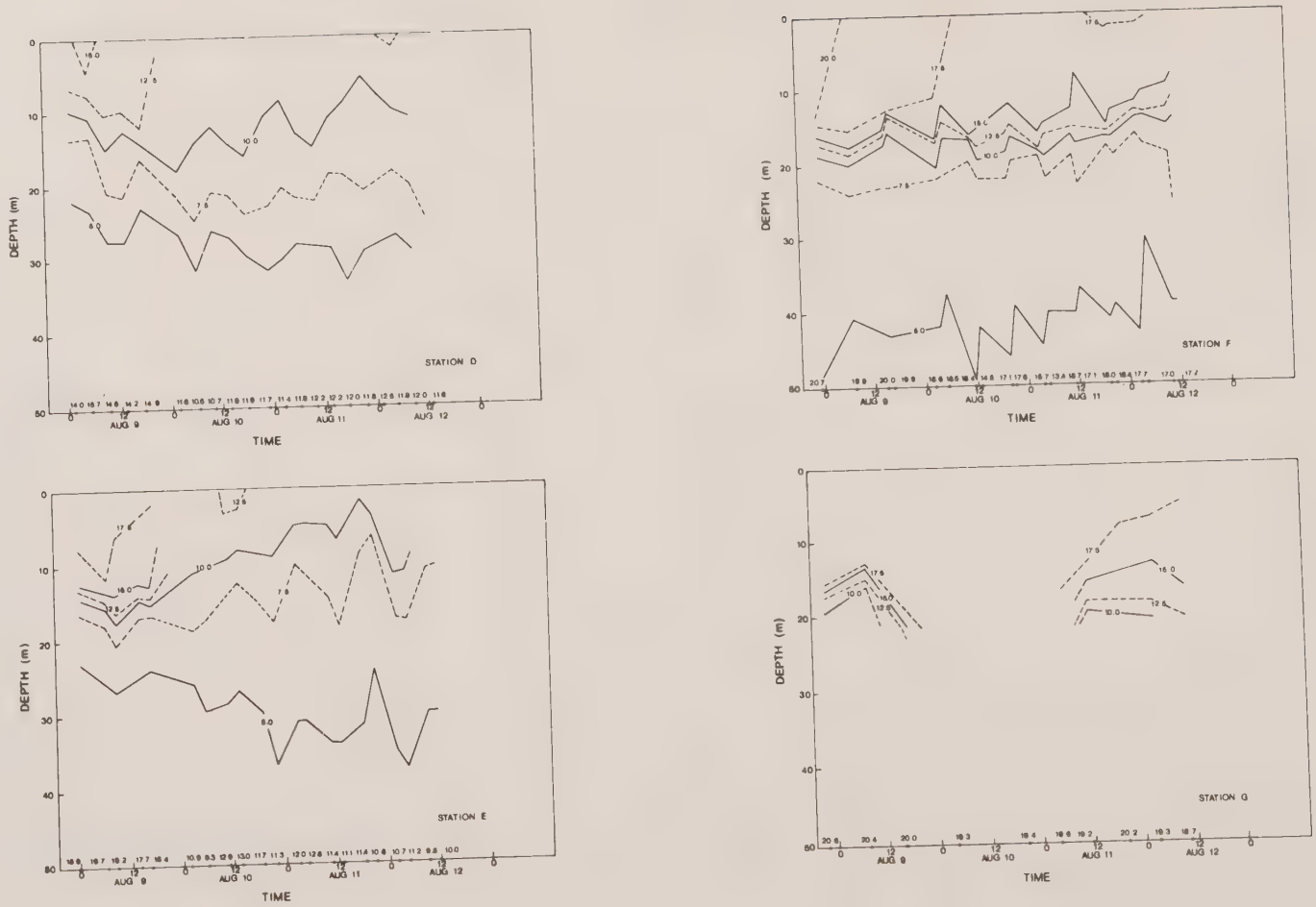

Figure 8. (Continued)

Results

During each of the 21 crossings of the lake, the Batfish dove at approximately 5 minute intervals to 50 m depths (or 10 m above bottom in the shallow regions). This is equivalent to a vertical temperature profile taken every 1.2 km along the line.

Long Period/Wave Length Internal Waves

A set of analogue data consisting of XY plots of temperature versus depth at Stations A, B, C, D, E, F, and G, (Figure 6, Table 10) located a along the transect line, formed the basis of this analysis. The data was first presented as time versus depth plots of selected isotherms for each of the seven stations.

Station A (Figure 8a) Situated at the north end of the transect, Station A was in effect sampled every 8 hours - not frequently enough to furnish more than a rough description of the long (> 16 hr.) period motion. A vertical oscillation of the entire thermocline (1st mode) appeared with a period of about 16 hours. The largest amplitudes occurred early in the record (10 m crest heights) and diminished thereafter. Warm water (> 18 °C) initially found on the surface at "A" disappeared with the onset of the strong wind. The disappearance appeared to be an advection phenomenon rather than a local mixing, because if anything, the main thermocline appeared nearer the surface at the end of the experiment than at the beginning.

Station B (Figure 8b) Isotherm motions in the main thermocline were in phase with each other. A marked 16 hour periodicity of vertical motion was observed, superimposed on a depression of the thermocline immediately following the wind impulse. Again, warm surface water disappeared following the onset of the wind but the surface temperature fluctuated with the thermocline motion - being warmest on the descending phase of the internal wave. A further interesting feature is the strengthening of the thermal gradients in the main thermocline towards the end of the experiment.

Station C (Figure 8c) The temperature gradients in the main thermocline were weaker here than at Stations "A" and "B". A 16 hour period oscillation appeared in the record, the isotherms moved in phase in the thermocline. The amplitude (~ 3.5 m) was greatest in the lower portion of the thermocline (7.5 and 5 °C isotherms). The motion of the 10 °C isotherm, located above the main thermocline, was out of phase with the motion of the thermocline itself and was such that the warmest water appeared on surface at the crest of the 16 hour period internal wave. This feature was contrary to the normal divergence-convergence expected on surface at the crests and troughs of large amplitude internal waves, nor did it fit with internal wave theory which predicted a decrease of amplitude approaching the free surface and

bottom. Following the wind pulse, there was a marked mean surface temperature gradient across the lake between Stations B, C, D, and E, with the temperature decreasing from north to south. Possibly the surface temperature fluctuations observed at Stations B, C, D, and E, were in part due to the rotary currents associated with inertio-gravitational standing waves. There was a tendency for the main thermocline to deepen during the experiment.

Station D (Figure 8d) The record at Station "D" again showed strong oscillations with a 16 hour period involving the entire thermocline region. Prior to the wind impulse, the epilimnion temperature was between 14 and 16 °C. Between 1600 on 9 August and 0200 on 10 August, this gave way to temperatures of 11 °C. At 0200 on 10 August the 10 °C isotherm was at the lowest point (18 m) and thereafter its "mean" depth decreased to a value of 10 m at the end of the cruise. The warmest surface water was found over the troughs in the 16 hour period oscillation. Below the 10 °C isotherm the temperature gradients weakened steadily. At first, the vertical movement of the 5 °C isotherm was in phase with the 10 °C and the 7.5 °C isotherms, but later this clear phase relationship was lost, perhaps because of higher frequency components which were not adequately sampled.

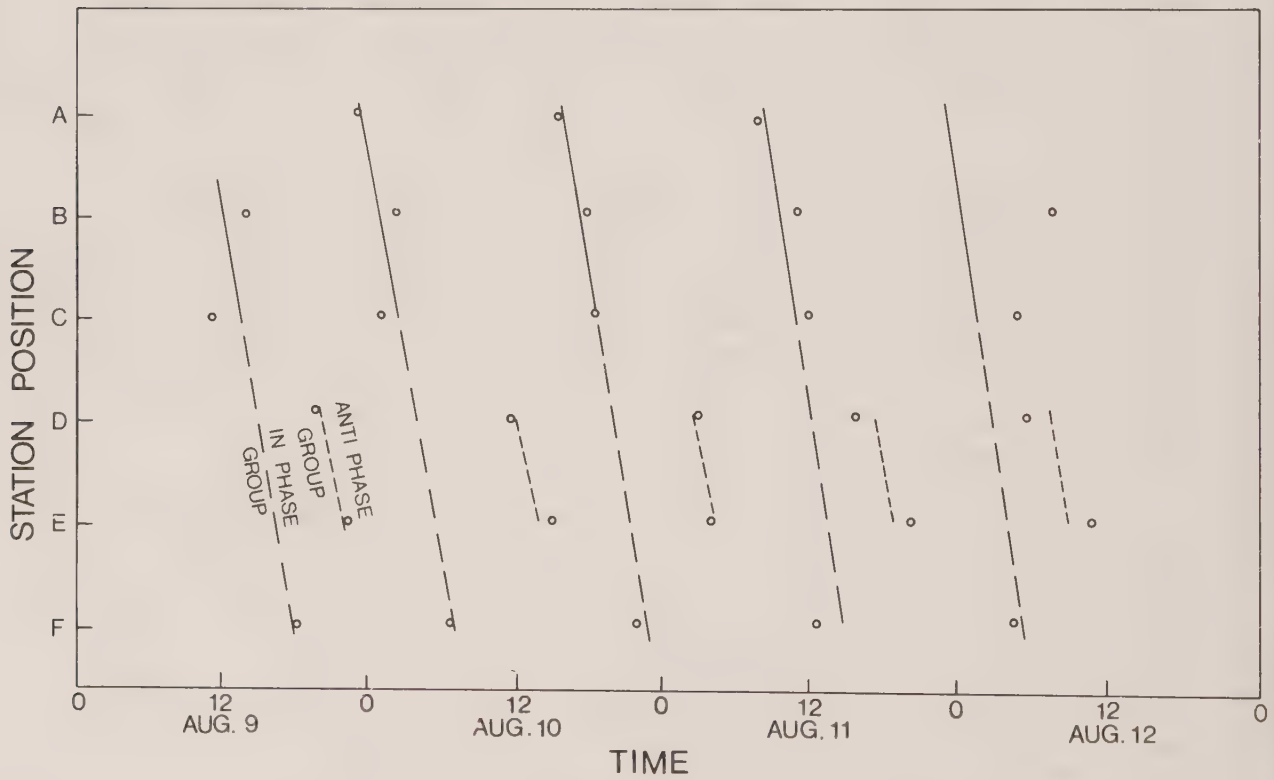

Figure 9. Time space plot of arrival times of the crests of long period (16 hr. normal) internal waves

Station E (Figure 8e) At Station "E" the 10 °C isotherm rose from 15 m at 1800 on 9 August to a minimum of 2 m at 1900 on 11 August. The 16 hour period motions were not well defined on this isotherm but were clearly marked on the 7.5 °C isotherm (mean depth 14 m). At this depth the amplitude of the 16 hour period wave increased with time, from 1.5 m to greater than 5 m at 0400 on 12 August. Below the 7.5 °C isotherm, the thermal gradients again weakened with time. The motion of the 5 °C isotherm appeared to be in phase with the movements of the main thermocline.

Station F (Figure 8f) The loss of warm surface water was not as extensive here as to the north although a pronounced cooling (from 20.8 °C to 14.5 °C on surface) was observed by 1200 on 10 August, which was followed immediately by a warming trend. There was a weak tendency for the thermocline to rise as a whole with time and no significant alterations took place in mean temperature gradients. The 16 hour period oscillations were much less evident here and appeared to be partially obscured by higher frequency components. At the level of the 5 °C isotherm an 8 hour period was found.

Station G (Figure 8g) At Station "G", located on the south shore, the onset of the strong winds was immediately followed by a depression of the thermocline to below 25 m from which it re-emerged weakened at 1200 on 11 August. No long internal wave components appeared on this rather fragmentary record.

Spatial Pattern of 16 hour period waves - Topography of the 10 °C isotherm.

When the times of arrival of the crests of the 16 hour period waves were plotted on a time-space diagram we observed, as on the previous cruise (10 - 14 July), a splitting of the observations into two groups - phase and anti-phase (Figure 9). The lines of constant phase again appeared to propagate southwards across the lake at about 6 knots (see the earlier report for an interpretation). Stations A, B, C, and F, formed the "in phase" group, Stations D and E the "anti-phase" group. By this interpretation the rotating standing wave pattern had at least two nodes, one between C and D and another between E and F.

Short Wave Length Internal Waves

Analogue recordings (strip chart) were made of the signals from 5 thermistors in the towed array at depths ranging from 1 to 26 m. This depth range straddled the main thermocline. Analogue data was examined qualitatively; its digital counterpart will be more throughly treated at a later date.

From this examination emerged a distinct sequence and pattern of events. Before the onset of the wind stress impulse, the level of activity could be described as low, with a few sporadic events encountered mainly between

Stations "D" and "E". During the period of strong winds (1300 to 2000 on 9 August), well marked trains of internal waves were encountered almost everywhere. Typical wave lengths of encounter were around 200 m and the activity was confined in the vertical to the region of strongest thermal gradients (density gradients). Both the wave lengths of encounter and the amplitude seemed to decrease near the shores. The large amplitude excursions were in phase at several levels indicating that these disturbances were in the first internal wave node. Some wave trains were coherent through more than 10 cycles.

With the north to south transect starting at 2350, 9 August, a distinct change in the short internal wave regime was observed. The offshore region (Stations "C" to "E") became very quiet; internal wave activity was mostly confined to isolated wave trains (wave lengths of encounter usually in excess of 500 m - ranging from 300 to 1300 m) which cohered vertically through two or more levels (5 - 15 m) and horizontally through 3 or 4 wave lengths. On several occasions evidence suggests the same wave train was crossed on two adjoining transects.

The thermal gradients in the thermocline in the offshore zone tended to be weak (see Figure 8c, d, e). Inshore, the thermocline gradients remained strong (Figure 8a, b, f, g). The active short internal waves appeared to be confined to this zone, with wave lengths of encounter around 200 m. This activity was most pronounced on the south shore.

The vertical extent of these movements was limited, confined in fact to a particular temperature surface. This was observed by virtue of the mean dip of the thermocline to the south. As the ship moved inshore the peak activity was observed at successively deeper levels on the towed array.

The separation between the inshore and offshore regions was well marked by a well developed frontal structure. The "south shore front" was particularly spectacular and was observed between Stations "E" and "F" from 0310, August 10, until the end of the experiment. A typical "towed array signature" of this structure is given in Figure 10. The "north shore front" was less well marked, and was not detected until 2334, August 10. Both "fronts" were detected via changes in surface temperature (warming inshore); it seemed as if the offshore and inshore regions were occupied by different water masses. The "south shore front" in particular was the locus of intense short internal wave activity cohering vertically through several towed array levels (10 m and more). This zone may well be the source of the isolated short internal wave events encountered in mid-lake.

Towards the end of the cruise both fronts weakened and became less well defined horizontally.

It is interesting to note in passing that the occurrences of short internal waves can sometimes be detected with the Batfish. Although the data was recorded and processed as vertical profiles, the vehicle dived at a slope

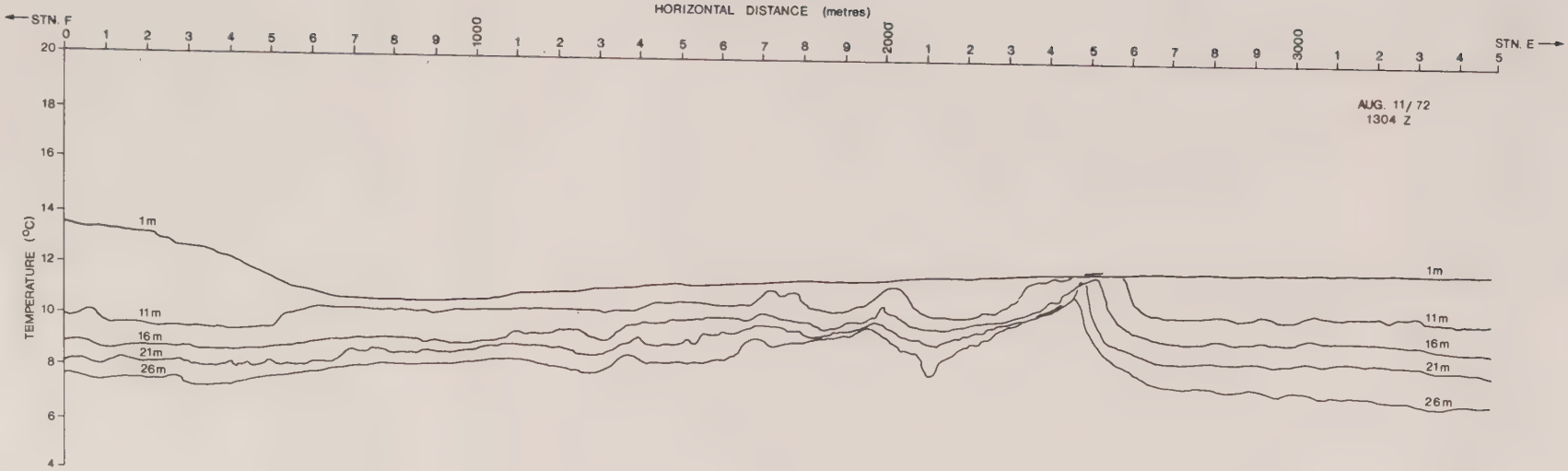

Figure 10. Example of typical "towed array signature" of the south shore front

of approximately 1 in 10. The passage of the Batfish through a train of waves produced a series of wiggles on the temperature depth trace, which amounted at times to substantial apparent temperature inversions. Comparison with the towed array records at equivalent time constituted a verification of the interpretation. The Batfish data served to locate the wave trains in the vertical.

Long Term Lake Response

In addition to the internal wave phenomena, the data also contained evidence of water motions at longer time scales (days). Figure 11a, b, c is cross-lake temperature sections corresponding to immediately before the wind pulse, 6 hours after the impulse, and 30 hours after the impulse. The situation prior to the wind impulse (Figure 11a) showed a doming of the main thermocline (see the 14 ^{o}C isothermal surface) in mid-lake. Bands of warm water existed along the shores and the entire structure suggested the existence of shore-bound currents (westward on the north shore and eastward on the south shore). Twenty-four hours later (Figure 11b) after the wind impulse, some distinct changes occurred. Surface temperatures across the whole section decreased, which would indicate substantial vertical mixing from the surface. The thermocline rose on the north shore and sank on the south. The heat content per unit area at Station "D" increased during this interval suggesting that warm water had moved from the north shore into mid-lake. These last two observations constituted evidence of an upwelling on the north shore. Twenty-four hours later again (Figure 11c) the domed structure of the main thermocline reappeared. The slopes of the isothermal surfaces near shore again suggest counter-clockwise shore-bound currents, more intense on the south shore than on the north. A weakening of the thermal gradients at the mid-lake Stations C, D, and E was also observed and indicated the presence of a vertical mixing within the fluid, as opposed to mixing from the surface.

Conclusions

The five-day cruise coincided with a well defined wind stress impulse, this was a rare and fortunate event. The experiment produced a wealth of data for future analysis.

The general impression was that the large-scale wind forced models of Mortimer and Csanady fit the observations reported here. In response to an eastward directed wind stress impulse, there was evidence of a sequence of upwelling and shore bound currents on which was superimposed a standing, rotating, internal wave system. The data on short internal waves suggested that there were at least two sources for this energy, one a direct transfer of energy from the wind stress, and the other, a localized source related to the frontal structures separating the inshore and offshore water masses.

The exact details of either mechanism are not understood at present.

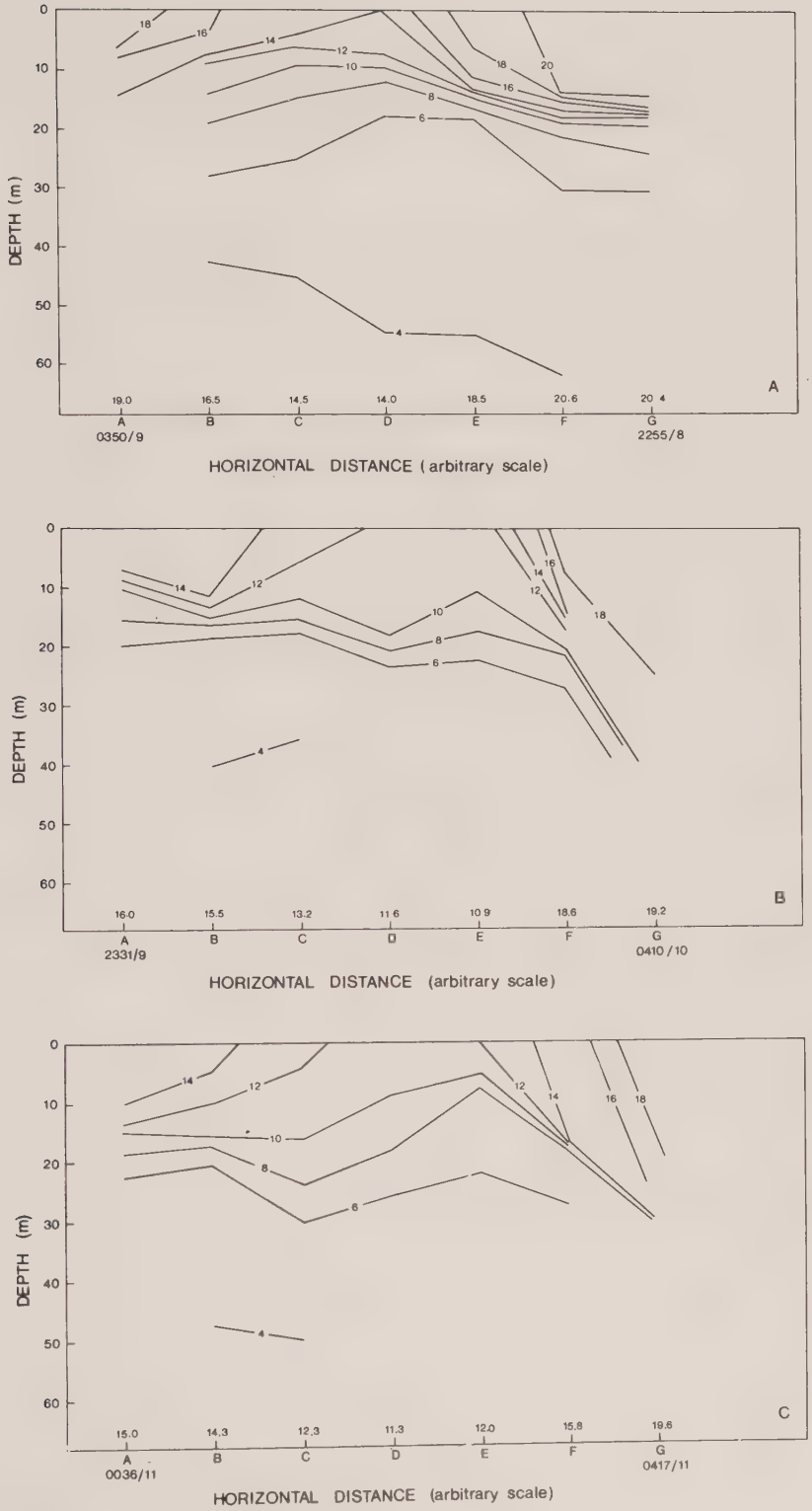

Figure 11. Three temperature cross sections of Lake Ontario, Oshawa to Olcott transect

Table 10. CSS Limnos Station Positions Temperature Transect Cruise

Station		Latitude N.	Longitude W.
Olcott	G	43° 21' 54"	78° 43' 58"
	F	43° 26' 00"	78° 45' 00"
	E	43° 30' 26"	78° 45' 13"
	D	43° 34" 59"	78° 47' 34"
	C	43° 39' 21"	78° 48' 48"
	B	43° 43' 38"	78° 49' 53"
	A	43° 48' 59"	78° 51' 16"

THE CCIW NIAGARA BAR MICROMETEOROLOGICAL PROJECT, FINAL STATUS REPORT

The primary objective of this program, the measurement of the vertical fluxes of momentum, heat and moisture by "profile" and "eddy correlation" techniques has been realized under a variety of wind speeds and atmospheric boundary layer stabilities. The location of measurements is shown in Figure 12.

There have been 40 successful runs from the "Turbulence" sub-system. These runs varied in length from 30 minutes to 90 minutes. They are best summarized on a scatter plot of wind speed versus boundary layer stability. Such a diagram is Figure 13 in which the gradient Richardson number is used as the index of stability.

The following table summarizes the operational periods of the mean profile sub-system (see IFYGL Bulletin No. 3, pages 10 - 11 for a description of the three sub-systems mentioned herein).

Table 11. Operational periods of the mean profile sub-system

Description	Continuous Operation From	To
Five levels of mean wind and temperature	19/5/72	27/5/72
	13/6/72	18/6/72
	20/6/72	26/6/72
Five levels of mean wind, temperature and relative humidity	18/8/72	5/9/72
	3/10/72	15/10/72

The Integrated Flux sub-system was fully operational from the 22nd August 1972 to October 15th, 1972.

All instruments and recording apparatuses have been returned to the laboratory and the site has been dismantled. All cup, propellor and hot-wire anemometers and humidity sensors have been calibrated at the Atmospheric Environment Service; all other instruments have been calibrated at CCIW.

M. Donelan

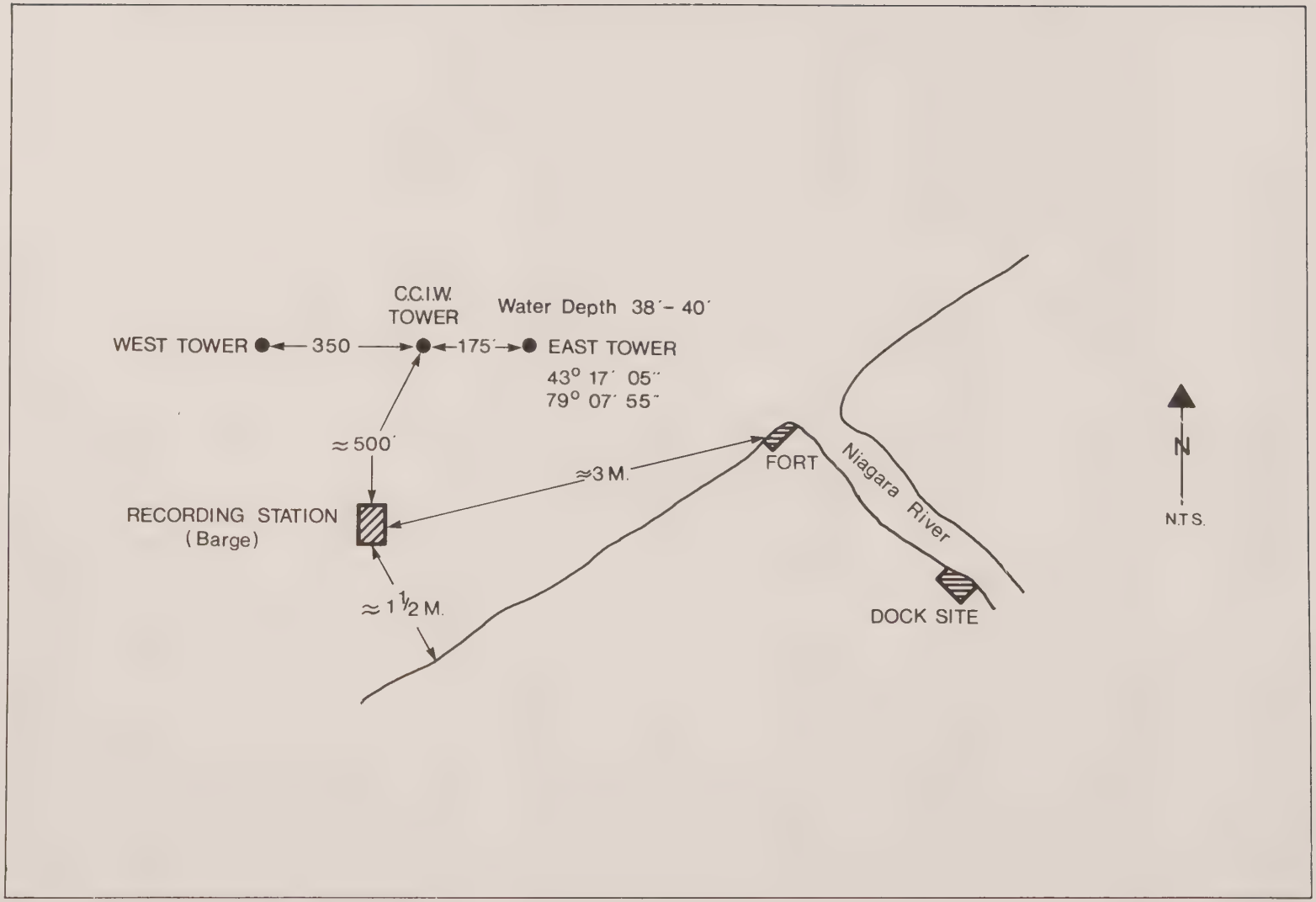

Figure 12. CCIW Micrometeorological field site, Niagara Bar.

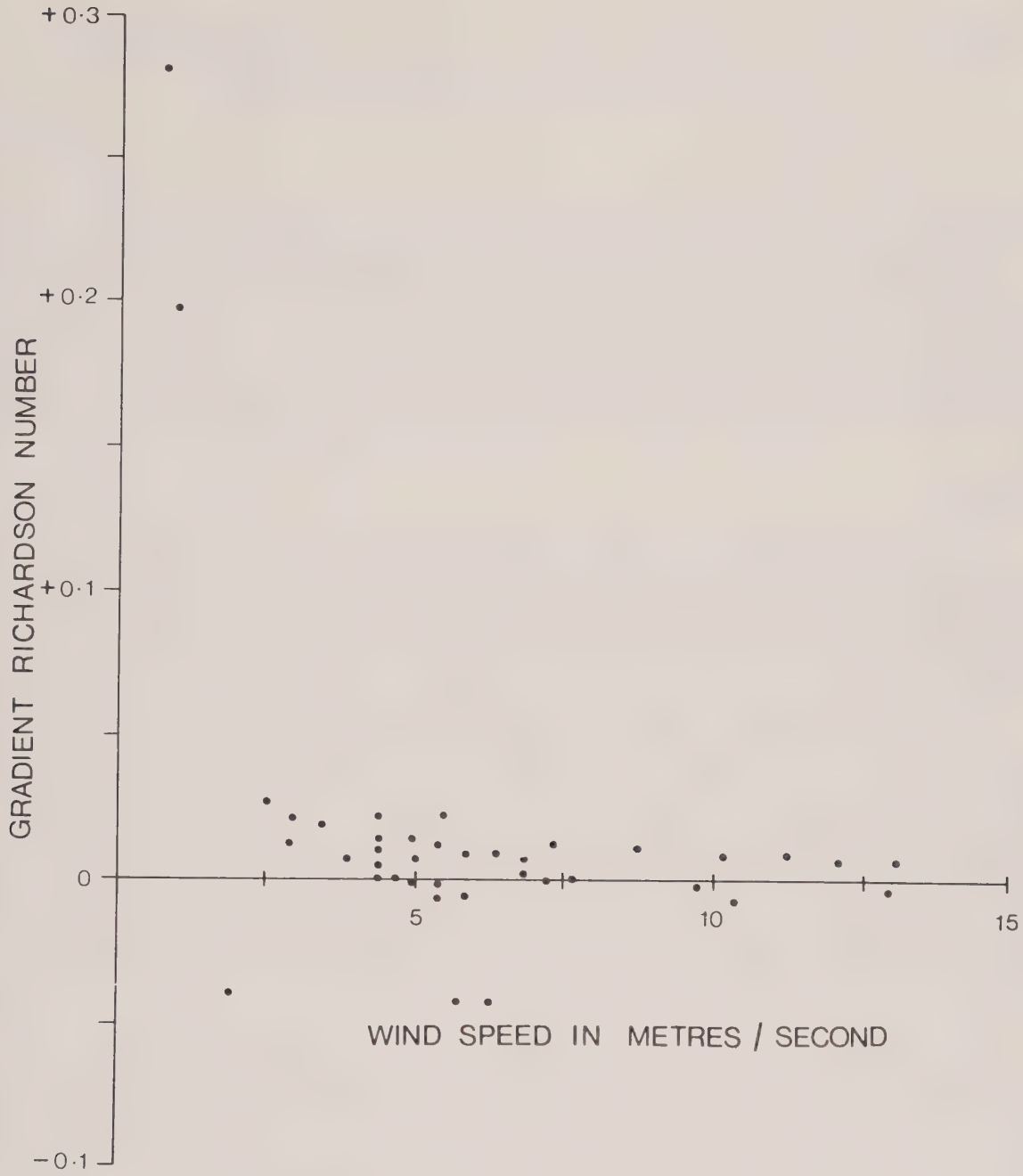

Figure 13. Scatter plot of wind speed vs. boundary layer stability. The measurements were taken as part of the CCIW Micrometeorology project.

THE OPERATION OF CCIW'S SHIPS AND LAUNCHES

Introduction

During the year 1972 some 82 IFYGL ship cruise reports were filed. The operation of these vessels was the responsibility of Ship Division in the Marine Sciences Directorate, Central Region, located at the Canada Centre for Inland Waters, Burlington. The contribution of Ship Division was very considerable to the success of the Canadian field operation program it is of some interest to record, therefore, the history and mode of operation, of this unit.

The History

Until the formation of Marine Sciences Branch in 1962, the hydrographic fleet was managed by the Canadian Hydrographic Service. With the emergence of the Division of Oceanographic Research as a fellow ship user in the new branch, Ship Division was formed as a separate entity to provide fleet support for both hydrographic and oceanographic programs.

With regionalization came regional based fleet support and regional operational control. When Inland Waters Branch was formed in 1966, Marine Sciences Branch, Central Region, was given the responsibility of providing operational support, including ships and launches, in the rapidly expanding field of limnology, principally to obtain data for an International Joint Commission report on the state of the Lower Lakes (i.e. Lakes Ontario and Erie). Although the responsibility for technical field operations was later shouldered by Inland Waters Branch by the Technical Operations Group of Great Lakes Division (now Lakes Research Division), fleet support remained with Marine Sciences Branch.

As a result of recent reorganization, Ship Division Headquarters became a Branch of Marine Sciences Directorate with certain responsibilities for other member fleets in the Department of the Environment, namely, Fisheries Research Board and Fisheries Protection Service. The overriding reason for this development was the fact that Ship Branch was the only ship organization with headquarters function, reporting as such to senior management and with direct liaison with other departmental headquarters such as the Ministry of Transport, Department of Supply and Services and the Department of National Defence.

In Central Region, the transfer of regional headquarters to CCIW where fleet support continues to expand, and the development of additional responsibilities have combined to increase the total function at the regional level and this has indeed been recognized by the elevation of the position of the senior executive position from Chief to that of Director.

Regional responsibility extends from the entrance of the St. Lawrence River to the Saskatchewan-Alberta border with northern activity in the high Arctic and in James Bay.

The Role

The Ship Division, Central Region, Marine Sciences Directorate, has an annual operating budget of close to $2 million dollars which is administered by the Regional Marine Superintendent, Mr. A. Quirk, with broad general direction coming from the Regional Director, Mr. T. W. D. McCulloch.

The prime objective of the Ship Division is the provision of complete a and diverse fleet support to hydrographic and scientific research programs. In simple terms, this support may be divided into three general areas; Operation, Acquisition and Maintenance.

Operation

Major Vessels: In order to maximize the utilization of resources on a hopefully impartial (by balance) basis, an Assignment of Vessels Committee has been formed, comprised initially of the Regional Marine Superintendent, Mr. A. Quirk, (Chairman), Assistant Regional Hydrographer (Hydrography), Head Technical Operations Sub-division, Lakes Research Division (Lakes Division and Monitor) and CCIW Program Co-ordinator (Other Users). The purpose of this committee, is the assignment of ship and launch time on a priority basis, with advice and guidance from the Regional Director of Marine Sciences Directorate and Inland Waters Directorate as required.

Once allocations have been generally established, it is the responsibility of the Ship Division to prepare, outfit and crew the various craft, subject to budgetary and man-year limitations, to meet the proposed schedule.

This applies less rigidly to major launches as some flexibility is necessary to meet changing situations and unforeseen circumstances which inevitably occur.

Once assigned to a project, each craft must, of course, be suitably equipped but also must conform with international, national and departmental regulations, and to Lloyd's requirements for a class vessel.

The personnel function demands a great deal of time and effort, due in the most part of the large turnover in the ships crew group. Manyear and budget restrictions do not permit the retention of reserve personnel and considerable lateral movement of troops is mandatory in the battle to keep the various units operational. The seasonal aspect of most field operations places certain limitations on the recruitment and retention of suitable personnel and although some of our key crew personnel are kept on strength during the winter months, the majority must be laid off, necessitating new recruitment each year. There is also, of course, involvement in other

personnel areas such as discipline, grievances, classification, staff relations and training.

All Departmental vessels in the region are directed and supervised by the Marine Sciences Directorate, based at Burlington. Most vessels are directly controlled and supervised, but where advantageous to all concerned supervision is delegated to other agencies, while in the case of chartered vessels, supervision occurs in the form of a contract monitoring exercise.

Acquisition

Although programs must sometimes be tailored to fleet strength, the general philosophy is that vessels be provided to meet authorised programs, both immediate and long term.

In the case of ship construction, a minimum lead time of three years is required once the general characteristics have been determined. A major launch takes some 12 to 24 months, depending upon design requirements.

When a high priority program cannot be supported from existing fleet strength, it may be necessary to find a suitable vessel for charter, and these negotiations usually require several months, although minor charters costing less than $50,000 are handled at the regional level and can as a rule be dealt with more quickly.

All but minor acquisitions are discussed in advance with vessel users and must be approved by the Director. Proposals for major vessels are subject to the approval of a ship construction program committee, comprised of members of senior Departmental management.

Maintenance

Entails the repair, modification and general maintenance of some 70 hulls and more than 200 mechanical units.

Facilities at CCIW afford a significant amount of in-house maintenance at a considerable financial saving. Much of the steelwork, machinery, welding, electrical work and mechanical repair must be contracted out, however at a cost of some $200,000 annually.

Although there is a concentration of repair activity during the winter period there is continuous activity throughout the year to maintain equipment in operating condition. As an indication of the volume of business, requisitions for parts and supplies are processed at the rate of approximately 800 annually.

The Future

The Ship Division of Central Region, Marine Sciences Directorate is essentially a support service and its future will be determined largely by departmental and departmentally sponsored programs. For the foreseeable future it would seem that demand for fleet support in this region will increase rather than diminish as the Water Management Service responds to the recent Canada-United States Agreement on Water Quality and the I.J.C. Reference for the Upper Lakes. It is also anticipated that activity will increase in the James Bay-Hudson's Bay area where a great deal of hydrographic and oceanographic work remains to be done.

General

This brief description of divisional activity within the region is intended to present a broad outline and obviously neglects to mention a host of individual functions which are part and parcel of the total support provided by the Ship group.

COORDINATOR'S NOTES

From the IFYGL History File

In Bulletin 3, pp 82-85, the history of the IFYGL was reviewed and reference was made to the following letter sent by Dr. D. V. Anderson to the Canadian National Committee for the IHD. It is particularly interesting at this time to compare the details of the proposal with what has actually happened. Remembering that Dr. Anderson played a minor formal role in the many subsequent detailed program planning meetings, it is remarkable how closely the IFYGL has in fact followed his ideas. The seed was indeed planted in fertile ground.

"Mr. R. H. Clark, Secretary,
IHD - Canadian National Committee,
150 Wellington Street,
Ottawa 4, Ontario.

April 5, 1965

Dear Mr. Clark:

Re: International Field Year in the Great Lakes

At the recent (29-30 March) Eighth Conference on Great Lakes Research in Ann Arbor, I was a member of a panel on cooperative programmes. Its moderator, Dr. G. K. Rodgers (Great Lakes Institute, U. of T.) had asked us to come prepared with concrete suggestions. Responding to his invitation, I made a proposal which seems to me, and to a few colleagues whom I have consulted, worthwhile putting forward to competent authorities for serious consideration. As your National Committee would be a principal judge I thought this would be a good time to describe it to you.

1. Proposal - To hold a cooperative, international "Field Year" in Great Lakes limnological studies under the (partial) auspices of the I.H.D.

2. Background - A proposal similar in intent although differing in context was put forward by Professor Portman, University of Michigan, a few years ago. He in turn took the O'Neill Nebraska Experiment as a model. (Ref. Exploring the Atmosphere's First Mile. Pergamon Press, 1957.) Various cooperative ventures have been and are being undertaken in the Lakes now,

but the mantle of the I.H.D. would surely strengthen Great Lakes research.

3. Principal Location - Lake Ontario. The choice of a lake upon which to focus attention is not critical in any one measure. Taking a few together, they favour Lake Ontario decidedly.

   (a) International lake (Lake Michigan ruled out).
   (b) Deep and therefore representative of other deep lakes (Erie ruled out).
   (c) Reasonably simple shape (Lake Huron and Georgian Bay ruled out).
   (d) Reasonably accessible (Superior ruled out).
   (e) Reasonably well described (Lake Ontario is best described of all).

4. Year - 1967.

5. Specific Purposes -

   (a) To improve observational, experimental and theoretical techniques in Lakes Research. (This would include education and guidance of workers.)

   (b) To encourage projects made possible by pooling equipment, skills, and analytical facilities.

6. Projects -

   (a) A few large projects would be chosen for concentration in Lake Ontario. These would be of the following sort: atmospheric water balance project (already proposed by Meteorological Service); infra red radiometry; circulation associated with "thermal bar"; Texas type limnological tower; air-sea interaction; large scale diffusion studies; buoy measurements (already being done); investigation of lake ice.

   (b) Many small scale projects would be given priority. These need not be done on Lake Ontario (some would be laboratory based or on theoretical subjects) but would be chosen to fit as small segments within the main projects. They would be such as could be undertaken by smaller, local institutions. For example, local circulation of Niagara River in Lake Ontario.

(c) Oceanographic research groups (Canadian, U.S. and foreign) would be invited to lend staff, and to send up research vessels for short periods. The educational value of this is obvious but special projects could be undertaken, in a well integrated programme. (There are already examples of the benefits from this kind of cooperation.)

(d) Manufacturers and consultants would be given field-days for demonstration of instruments and skills.

(e) Workshops and seminars would be held on specific projects.

(f) Through the initial help of specialists, groups with interest and ability would be properly launched on field, laboratory and theoretical projects.

7. Consequences - Great Lakes problems in the main have proven to require more than the unilateral power of single groups. Cooperative efforts are essential, in the public interest, and all work should be vetted by experts. That this has not been so has caused much waste and inefficiency. One year's concentrated joint attack on one lake should give immediate improvement in technique and show the power and limitations of the best methods available. Great Lakes research workers have not been able to avail themselves of the best and the standard of activity has not always been commensurate with the importance of the work. The results of a concordance of effort would be far reaching in limnology, and in view of the size of the Lakes problem, the I.H.D. would both strengthen it and be strengthened.

While the proposal is a broad one, please note that it does not necessarily involve large and new funds. Rather it requires only doing "this, here" rather than "that, there" within one year.

The project could only be a success if it were enthusiastically and widely supported. I am pessimistic about the response to this proposal, but I believe that agencies that cannot cooperate rather generously are probably not going to contribute in just proportion to the public weal. Perhaps I could say, not tendentiously but provocatively, "If this project is not supported, it will be an indication that we shall have to content ourselves with less than the best in laying foundations for management of the Lakes.".

As I have no formal position in this please treat this as a personal brief for your thought and, hopefully, for your attention.

Since there is an immediate opportunity of sounding Canadian opinion at the C.C.O. meetings at month's end, I have invited Dr. Rodgers to discuss this proposal with his superiors. As you know Dr. Langford is a member both of your Committee and the C.C.O. I have also given copies of this letter to the Canadian Co-chairman of physical studies in the Great Lakes (D. K. A. Gillies), and to Dr. V. Noble of the University of Michigan who has expressed interest in the idea.

Yours truly,

D V Anderson

D. V. Anderson"

Biological-Chemical Panel Meeting

A very successful Panel Meeting was held at the Sheraton-Brock in Niagara Falls, Ontario, on 14 and 15 November 1972. The attendance was fifty-three (Canada 14, U.S.A. 39).

The meeting was convened and chaired by the Panel Co-chairmen, Nelson A. Thomas (U.S.A.) and W. Jack Christie, (Canada). Supporting services were provided by the U.S. and Canadian Coordinators.

After welcoming participants Messrs. MacDowall and Callahan were called on to give a brief review of the status of the whole IFYGL program and they presented slides showing work in progress. The chairmen recalled the Washington Workshop (January 1972) and the stated program objectives. Prior to the meeting all were requested to give special consideration to: status; highlights; intercomparisons; and, data needs from other panels. Four stages of reporting were, visualized: 1) status reports; 2) intrataxon analysis; 3) intertaxon analysis; and, 4) generalized models. An immediate objective of the meeting was to agree on the assignment of responsibilities, and to define a time scale for the stage one reports. The Panel endorsed this approach and then split up into the following working groups:

Working Groups		Co-chairmen
Materials Balance	G. F. Lee	M. Shiomi
Phytoplankton	W. Glooschenko	G. Stoermer
Cladophora	G. Owen	F. Polcyn
Zooplankton	N. Watson	Marlene S. Buzzard (for D. McNaught)
Benthos	S. C. Mozley	M. Johnson
Fish	W. Hartman	D. Huxley

Working Group reports were prepared, presented and discussed in Plenary Session on the second day, and then handed in to the Coordinators. Reports were compiled at the Canadian IFYGL Centre by Mr. J. MacDowall for distribution to attendees, and on request. Some of the points from these reports were noted by the Coordinator because they may be of general interest. The selection was arbitary and was not necessarily considered to be the most representative. For a proper appreciation of the Meeting it is necessary to refer to the full report.

The extent of the fish program was summarized. Some 100 000 samples were taken, 50 000 measurements made and 53 species noted. No lake trout or deep ciscoes were found. A catalog of fish data was commenced. The reporting phases were as follows:

1. Relative abundance, lake wide;
2. Feeding habits, size, age and growth analysis;
3. Interrelationships.

The long range plan was referred to aimed at refilling the "whitefish niche" with burbot and splake.

The remote sensing of cladophora program, jointly undertaken by the Canada Centre for Remote Sensing and the Ontario Ministry of the Environment has produced useful data, as has the U.S. program. Photographs from a height of about 2.0 km in Canada defined the areal extent of cladophora beds in the eastern 133 miles(214 km) of Ontario's shoreline, out to a water depth of 5m. Attempts will be made to define the extent west of Port Hope in 1973. More work is required in order to complete the survey.

The Phytoplankton and Materials Balance groups recommended that some U.S. investigators continue their studies in the spring of 1973 to compensate for the work they could not do in 1972. This recommendation was brought to the final plenary session, was duly proposed, seconded and voted on by the International Panel as a whole. In giving their unanimous support for this proposal it was noted, by Dr. C. Mortimer, that such a modest continuation of work would "more than double the value of existing data". Difficulties in finding logistic support to undertake this work were anticipated.

Several aspects of concern were expressed regarding the data analysis phase. A second Panel resolution was passed calling for the maintenance, through the data analysis phase, of existing investigating teams to ensure the speedy analysis of data. It was hoped that initial reports could be prepared before the end of the IHD in 1974. The Panel is planning to issue phase 1 reports on the status-of-the-lake when most of the data are available. The dates of availability of data are as follows:

Benthos	April-October 1973
Phytoplankton	1973 Raw Data, Summer 1974 Taxonomic Data
Materials Balance	December 1973 to February 1974
Intercomparisons	Summer 1973
Cladophora	December 1972
Fish	December 1973
Zooplankton	Fall 1973.

In their written reports participants provided considerable detail on work done or in progress. All participants are to be congratulated for the individual efforts which went into making the meeting such a success.

Ship's Activity

Since the issue of Bulletin 4, 23 additional cruise reports were filed with IFYGL Centre bringing the total to 76 for the period from the beginning of April to the end of November 1972. With the onset of fall, stormy weather frequently affected the plans and necessitated the use of added cruises in order to keep the program schedule. For further details see Bulletin #4, pp. 48 - 52.

Heat Content and Surface Eutrophication Survey

In July, August and September, United States vessels undertook this study. From 3-6 October 1972, the Canadian ships MV Martin Karlsen and CCGS Porte Dauphine returned to this task and completed the eighth Canadian survey.

Cross Lake Temperature Transects

The third and final transect was done from 2-6 October 1972, by CSS Limnos. A preliminary analysis of the first two surveys (10-14 July and 8-12 August 1972) was prepared by CCIW. The August transect coincided with a marked wind stress impulse and the preliminary analysis is included in this issue of the Bulletin.

Ontario Organic Particle Study (OOPS)

The fifth, sixth, and seventh cruises of this nine-cruise study were done on 5-16 September, 17 - 28 October 1972, and 20 November - 2 December 1972. The NASA Cleveland remote sensing aircraft made spectral reflectance measurements over the OOPS stations on 26 and 27 October.

Diffusion Study

The final three cruises of this six-cruise study were completed on 28 August - 9 September, 25 - 30 September, and 16 - 20 October 1972. In addition to the work of Dr. C. R. Murthy, referred to in Bulletin 4, the last four diffusion cruises also carried Dr. G. Kullenberg and Mr. H. Westerberg from Copenhagen University, working on project 114WM described in the compilation of Canadian Projects on p. 212. Excellent results were obtained by our visiting investigators using the in-situ fluorometer.

Bathymetric Survey

The second and third cruises of CSS Limnos took place on 11-22 September 23 October - 10 November, 1972; meteorological and limnological data were acquired and buoys serviced. Bathymetric survey of the lake east of 78°W was reported as 85% complete after the September cruise. To date 5241 nautical miles of bathymetry was acquired in these three cruises. An additional and final bathymetry cruise was planned for 27 November - 1 December 1972, to

make up for time taken up in the servicing of IFYGL Buoys during the third survey.

Buoy Maintenance and Service

Table 12. Canadian Buoy and System Service Cruises (a continuation of Table 9 in Bulletin 4, p. 54)

System	Dates 1972	Ship[1]	Task
Decca	17 - 19 May	MK	Decca calibration and equipment evaluation
Decca	28 - 30 August	MK	Decca calibration
Meteorological	5 - 10 September	LE	Maintenance of met. and FTP buoys
Meteorological	18 - 24 September	LE	Maintenance of met. and FTP buoys
Meteorological	2-6 and 10-12 October	LE	Maintenance of met. buoys
Meteorological	30 October - 3 November	LE	Maintenance of met. buoys
Meteorological	6 - 8 November	LE	Maintenance of met. buoys
Meteorological	19 - 24 October	LE	Maintenance of met. buoys
Meteorological	15-16 November	L	Maintenance of met. buoys
FTP	12 - 15 September	LE	Install FTP - 11, maintain 9, 10 and 6
Current Meters	11 - 16 October	MK	Maintain current meters and retrieve FTP stations 9, 10 and 11
Moorings and Coastal chains	30 October - 1 November	L	Buoy service (Time out from Bathymetric Survey)
Current Meters	20 - 25 November	L	To place 9 winter moorings

[1]MK - Martin Karlsen L - Limnos LE - Lac Erie

The cruises undertaken by CCIW in order to maintain and service the IFYGL Lake Observing Network are shown in Table 12. Rough weather necessitated the use of more effort than was originally planned in order to keep systems operational.

Aircraft

Lake Surface Temperature by ART

From September to 11 December 1972 an additional 15 flights were completed and the isotherm maps were distributed. The dates of survey were:

6, 11, 21 and 28 September; 2, 5, 10, 18, 25 and 30 October;
6, (16), 21 and (28) November, 11 December 1972.

On 16 November, the surveying was incomplete because permission was not granted to survey the U.S. area between Little Sodus Bay to Troutburg.

Canada Centre for Remote Sensing

A mission summary is given in Table 13. Fuller details are given in Bulletin 4 pages 9-12, 52, and 55-59.

NASA Flights

The RB57F aircraft, tasked by Manned Spacecraft Center, Houston, overflew a 10 000 n mi.^{2} area in the Lake Ontario Basin on the following dates:

6 July	1970
19 October	1970
29 May	1971
5 June	1972
7 June	1972

Details of this program are given in project 70.

NASA Cleveland overflew the OOPS station on 26 and 27 October 1972, and made spectral reflection measurements.

Table 13. CCRS Remote Sensing Activity Associated with IFYGL

Investigator	CCRS No.	Date	Height AGL (M)	Sensor	Film	Filter	Focal Length (mm)	Size (mm)
K.P.B. Thomson	72 14	28/8/72	10800	C	2445	-	88	228
				C	2443	W12	76	70
				RS14	Thermal	Scanner		
		29/8/72	10800	C	2445	-	88	228
				C	2445	HF3	76	70
				C	2443	W12	76	70
				RS14	Thermal	Scanner		
K.P.B. Thomson	72 15	28/9/72	1830	C	2402	-	76	70
				C	2445	-	76	70
		27/9/72	1830	C	2445	-	76	70
				C	2402	-	76	70
		2/10/72	1830	C	2405	-	76	70
				C	2445	-	76	70
		4/10/72	1836	C	2405	-	76	70
				C	2445	-	76	70
		21/8/72	-	Daedalus Scanner			-	70
		25/8/72	1220	Daedalus Scanner			-	70

The Level of Lake Ontario

The level of Lake Ontario fell about 2 ft. from the high level of July, and in November was about 0.5 ft. above the long term mean for the time of year. Water supplies to the Lake have been at near record values and the outflow in the St. Lawrence river is the maximum practicable for these level conditions. It is anticipated that high lake levels will occur again in the 1973 field season.

The actual levels recorded at the six Canadian stations are given in Table 14 . The Table is a continuation of data given in Bulletin 4 on p. 44; please note that the April to July levels for Pt. Petre should read 245.28, 246.03, 246.23, and 246.57 respectively.

Table 14. The Monthly mean elevation in 1972 of the surface of Lake Ontario above the Mean Sea Level in the St. Lawrence at Father Point, P.Q. (feet).

	August	September	October	November
Port Weller	246.37	245.62	244.84	244.63
Toronto	246.48	245.71	244.90	244.69
Cobourg	246.47	245.72	244.91	244.68
Kingston	246.38	245.59	244.82	244.51
Burlington	246.53	245.76	244.98	
Pt. Petre	246.28	245.57	244.89	

The Great Lakes-St. Lawrence Study Office, Cornwall, Environment Canada, provided the above information. This office also used both United States and Canadian Data to calculate the mean level for the whole lake as given in Table 15.

Table 15. The mean monthly level of Lake Ontario in 1972 above Father Mean Sea Level at Father Point, P.Q. (feet).

Month	Level (ft.)	Month	Level (ft.)
April	245.37	August	246.37
May	246.22	September	245.60
June	246.39	October	244.82
July	247.68	November	244.58

Project List

The following are recent changes and additions to the project list given in Appendix I, Bulletin 2, (see p.53 Bulletin 4 for previous changes). As before, new projects are described only briefly. More information on these projects together with progress reports provided by the project leaders can be found in Canadian Projects and Canadian Projects, Supplements 1 and 2, available from the Canadian IFYGL Centre, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario.

98BC, 101BC, 102BC	Add M. Munawar as investigator.
110 WM	To determine the temperature and current climatology near proposed generating stations (A. Arajs, Ontario Hydro).
114WM	To determine vertical and horizontal diffusion parameters by in situ observations of dye plumes (G. Kullenberg, University of Copenhagen).
115WM	To establish the climatology of waves by visual observations (H. K. Cho, CCIW).
116TW	To determine the accuracy of the airborne gamma radiation technique for measuring snow cover water content (H. S. Loijens, IWD/GSC).

Winter Moorings for Current Measurements

During the winter period of the IFYGL the only synoptic current measurements will be made by Canadian moorings. The United States system utilized a surface buoy (see Bulletin 3, p.38) which is not designed for winter use.

The Canadian and United States Water Movement Panel Cochairmen recommended that their available joint resources be deployed lake wide. This recommendation was accepted by the Management Team.

The network comprised nine moorings at the locations shown in Figure 14. The type of meter and its depth is given in Table 16. It will be noted this winter network includes eight of the previous locations plus one new station off the United States shore between Rochester and Sodus Bay. Current flow and temperature will be recorded at half hourly intervals at 15 and 75 metres depth.

The moorings were set in the third week of November 1972 and will be recovered in the third week of March 1973.

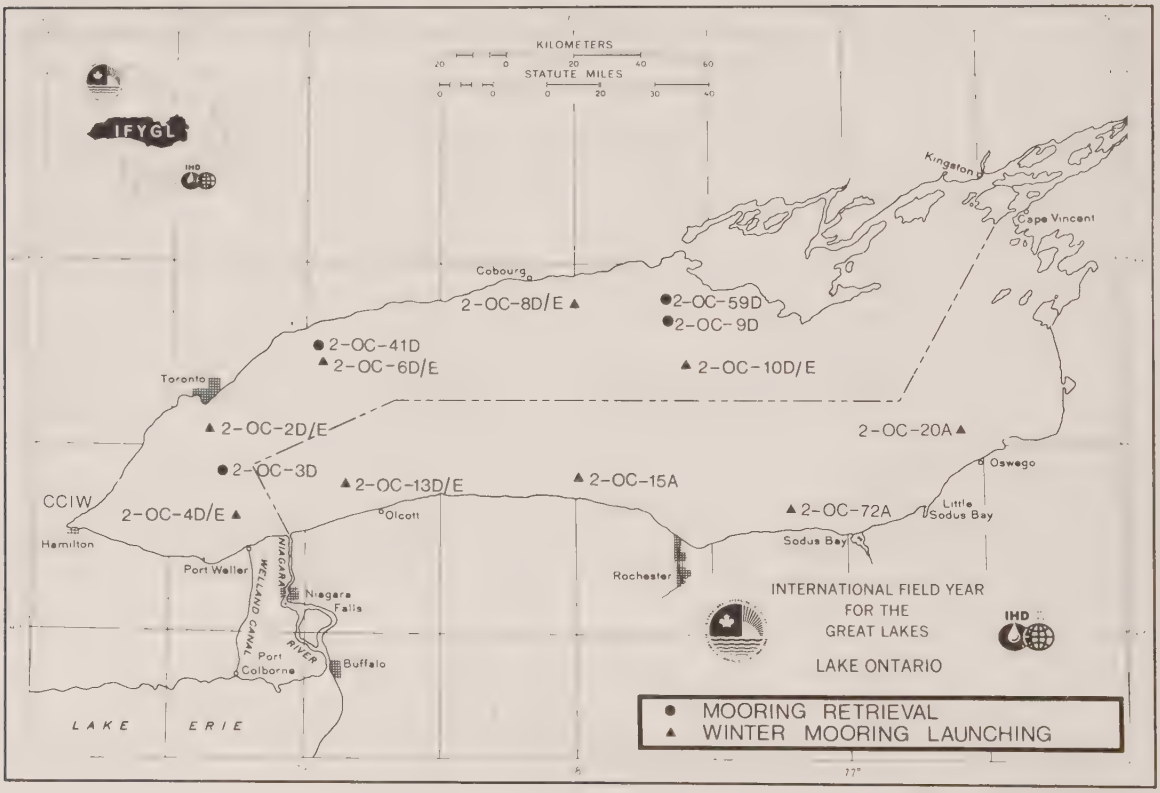

Figure 14. Location of winter moorings on Lake Ontario

Table 16. Summary of launching of winter moorings giving type, location and depth. All are deep water moorings launched on CCIW cruise 72-00-027.

Mooring Number	Current Meter Type	Depth (m)	Location
2-OC-2E	Plessey	14	43° 31' 09" N
	Geodyne	16	79° 19' 30" W
	Geodyne	75	
2-OC-4E	Plessey	14	43° 18' 58" N
	Geodyne	16	79° 13' 59" W
2-OC-6E	Plessey	14	43° 44' 11" N
	Geodyne	16	78° 49' 06" W
	Geodyne	75	
2-OC-8E	Plessey	14	43° 49' 34" N
	Geodyne	16	78° 02' 37" W
2-OC-10E	Plessey	14	43° 40' 23" N
	Geodyne	16	77° 42' 56" W
	Geodyne	75	
2-OC-13E	Plessey	14	43° 26' 04" N
	Geodyne	16	78° 43' 40" W
	Geodyne	75	
2-OC-15A	Plessey	14	43° 27' 00" N
	Plessey	16	78° 00' 00" W
	Geodyne	75	
2-OC-20A	Plessey	14	43° 32' 00" N
	Geodyne	16	76° 38' 00" W
	Geodyne	75	
2-OC-72A	Plessey	14	43° 21' 00" N
	Geodyne	16	77° 15' 00" W
	Geodyne	75	

Lake Ontario Basin Weather Data

This monthly Atmospheric Environment Service (AES) publication contains summarized data from various internal and official publications of AES and the United States National Weather Service. It will be published during the data gathering phase of IFYGL in support of those projects which require a comparison between actual and "normal" weather conditons. With a few exceptions, 1941 - 1970 averages were used as the basis for comparison.

Monthly climatic means and extremes were tabulated for 35 Canadian and 35 United States stations, in addition fuller weather details were given for 20 (15 in Canada) selected first order stations. Means and departures of air temperature (mean daily maximum, and daily minimum), precipitation, and snow fall were illustrated by ten charts covering the whole basin. The units used were the non-metric system currently employed by the Canadian and United States weather services.

April 1972 was one of the coldest Aprils on record, temperatures were 2 to 4^{o}C below normal. Snowfall was above normal, but precipitation was below normal. The month was a sunny one with lighter than normal winds. Toronto Island Airport recorded its lowest ever average April wind speed of 4.1 m/s.

May 1972 was a month of variable weather. Below normal precipitation occured in Ontario (40 mm in Toronto), whereas record breaking high amounts occured in New York (157 mm in Syracuse). The cold weather of early May soon warmed up so that means were slightly above normal. Much of the basin experienced a sunny month with lower than normal wind speeds.

June 1972, was one of the coldest and wettest Junes on record in the Lake Ontario Basin. New records were established for low temperatures and high amounts of precipitation. Below normal amounts of sunshine and lighter than normal winds were experienced. From 20th to 25th June, the tropical storm Agnes passed on a track lying to the South East of the basin, the storm fringe greatly affected the weather, particularly in New York State.

UNITED STATES

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COMMENTS BY THE U.S. DIRECTOR

This issue covers mainly activities for the second quarter of the Field Year, July 1 to September 30, 1972 (see fig. 1), but a few more recent events of October and November are also included. Since July 1, 1972, the major accomplishment has been the deployment, operation, and maintenance of the IFYGL data collection systems and the implementation of data management procedures. The operations plan for data collection contained in IFYGL Technical Plan, Volume 3, has been followed rather closely, data collection having averaged between 60 and 90 percent of the plan.

Hurricane Agnes caused flooding from June 21 to 24, an event that had a significant effect on the stage, streamflow, and load of the major Lake Ontario tributary streams. This in turn affected the load in the coastal waters of Lake Ontario, and debris fouled several current meters on the towers as well as the buoys further offshore.

This quarter has been one when the data acquisition systems shakedown was essentially completed for the buoys, ships, radar, and aircraft and we settled into an operating routine. We had our maintenance problems, or challenges, depending upon one's viewpoint. Shakedown of the ship data acquisition system was slow because of repeated failures, and sea cables were treated as expendables. We improvised when required, using XBTs when there were problems with the EBT. Accommodating the number of participants desired for biological-chemical cruises required some ingenuity.

With these problems solved and challenges met, a large amount of apparently useful data was collected during this quarter from the ships *Researcher, Advance II, Kaho, Shenehon, Dambach,* and the Oswego T-boat and smaller boats, during temperature cruises, benthic cruises, biological-chemical cruises, transect cruises, pelagic trawls, etc.

The Texas Instrument system operated much better than expected, and yielded a large data base. In addition to the adverse effects of Hurricane Agnes, buoy maintenance from the small boats *Johnson* and *Jane 1* was impractical during the storms of July and August. This resulted in some buoy downtime during the quarter due to temporary fuel exhaustion and the resulting loss of power. Communication problems on some buoys and the ingenuity of the maintenance staff resulted in the development and installation of 11-day cassettes for on-board recording. As of November 17, all TI buoys and towers have been retrieved. No further deployment of these systems is planned for IFYGL.

The aircraft data acquisition systems operated very satisfactorily during their alert periods. The weather radar also functioned very smoothly, with equipment malfunction limited to one short period.

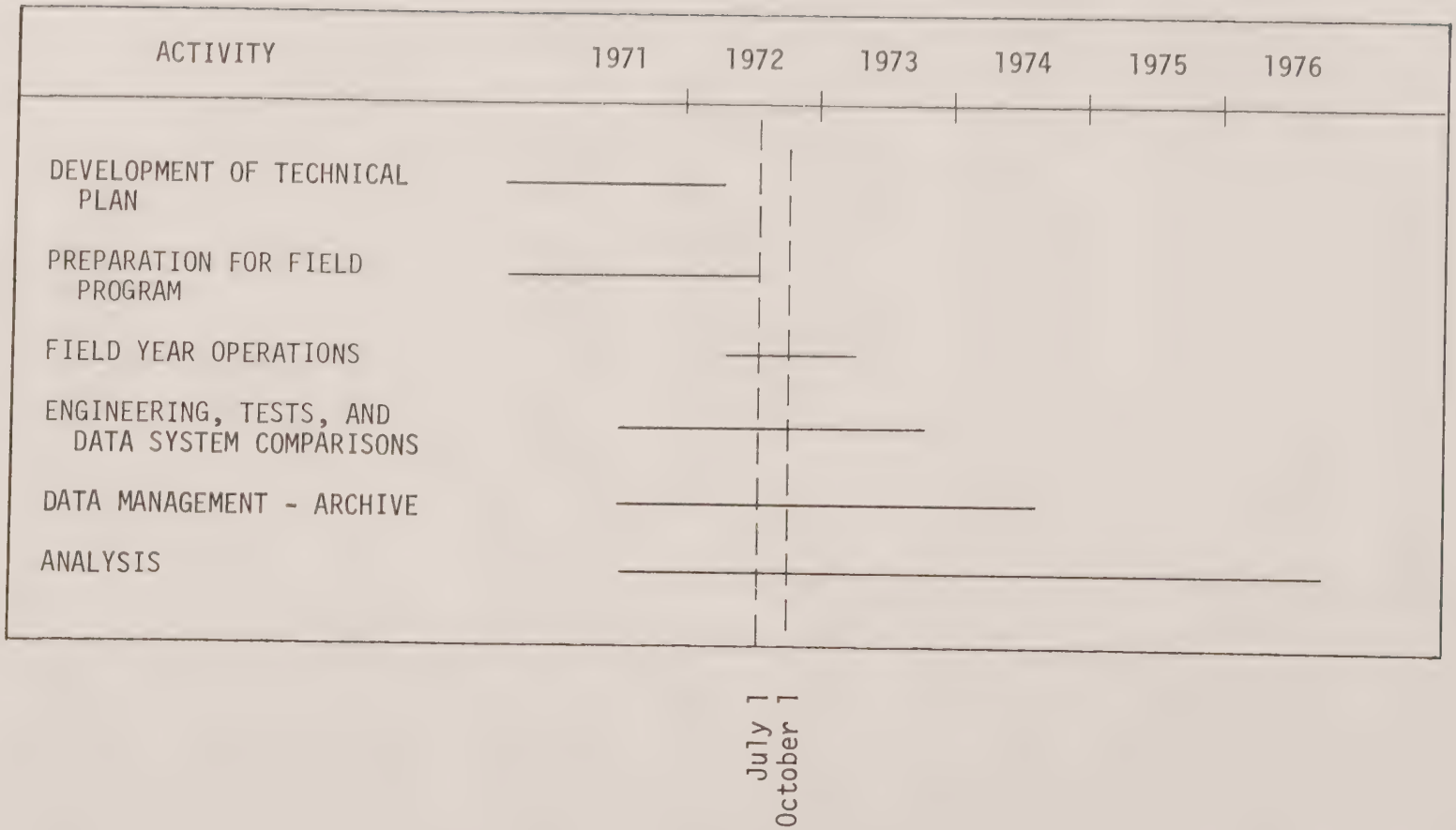

Figure 1. U.S. IFYGL schedule.

The rawinsonde data acquisition system was deployed during September. A shortage of available expendables and some shakedown difficulties called for the utmost in ingenuity and performance from operations and maintenance personnel. This system is now operating well.

Intercomparison of the data acquisition systems was made aboard the United States vessels on August 17 and 18 and between United States and Canadian vessels on September 18. Standard chemical samples were prepared and distributed for intercomparison by the United States and Canadian chemical laboratories.

The data management activities at the Rochester Field Data Center have been intensive with the development and maintenance of documentation logs and data records. Other data management activities are gaining momentum. The development of software for processing data from the automatic ship, rawinsonde, and TI systems is continuing.

Some organizational changes took place during the quarter. Nelson Thomas, EPA, replaced Norbert Jaworski, EPA, as U.S. Cochairman for the Biology and Chemistry Panel. Tudor Davies, EPA, is now a U.S. member of the Joint Management Team and has assumed IFYGL responsibilities previously held by Norman Glass, EPA.

U.S. SCIENTIFIC PROGRAM

Based upon reports requested by the U.S. IFYGL Project Office and on the IFYGL Data Catalogue monthly mailing returns, the progress from July 1 through September 30, 1972, is presented for each of the U.S. IFYGL tasks. Some task reports cover work done after September 30. Project progress reports follow the task reports.

Tasks

1. *Phosphorus Release and Uptake by Lake Ontario Sediments*

Principal Investigators: D.E. Armstrong and R.F. Harris - University of Wisconsin

Characterization and investigation of sediment samples obtained on the June benthic cruise aboard the *Advance II* are nearly completed. Study of sediments from the postglacial muds and the glaciolacustrine clays show a range of interstitial inorganic P from 6 to 135 µg/1. Total sediment P ranged from 800 to 4,000 µg/g; total inorganic P was high (780 to 3,100 µg/ compared with total organic P (22 to 285 µg/g). The inorganic P from post glacial muds contained relatively high proportions of nonoccluded P and apatite. The glaciolacustrine clays appeared to contain low amounts of nonoccluded P and a high proportion of apatite. Interstitial P removed by removal of interstitial water was readily replaced in added water by desor tion of sediment-bound P. Most sediments readily sorbed added P, but addition of relatively low amounts of P caused a relatively large increase in the equilibrium level of inorganic P in solution. Investigation of sam ples taken during the second sampling trip (November 1972) will be focused on interstitial inorganic P, chemical mobility of sediment inorganic P, an the release of P from sediment cores maintained under controlled laborator conditions.

2. *Net Radiation*

Principal Investigator: M.A. Atwater - CEM

Data now on hand comprise the Buffalo radiosonde data from June 1 through August 27, Service A hourly surface observations from June 7 throu August 27, surface observations and lake surface temperature data from the *Researcher* and *Advance II* at selected intervals during the period July 10 through September 22, and Oswego surface observations for all dates throug late September. The Rochester Data Center is now sending the required data on a routine basis.

Preliminary maps of cloud analyses and daily radiative fluxes were computed for 7 days (July 17-20 and July 25-27). Data extraction and processing is underway for the remaining days in the June-August period.

A computer program was written to process and analyze lake surface temperature data. All such data received to date have been processed and analyzed.

Initial results from the radiation computations, cloud analyses, and lake surface temperature analyses indicated that the cloud submodel, and specifically the subroutine accounting for lake effects on low cloud amount, required refinement and development. This result was anticipated, and refinement is now underway.

3. *RFF/DC-6 Boundary Layer Fluxes*

Principal Investigator: B.R. Bean - ERL/NOAA

No report.

4. *Nitrogen Fixation*

Principal Investigator: R. Burris - University of Wisconsin

During the July 12-14 cruise aboard the *C.A. Dambach*, stations 1-24 between Welland Canal and Rochester were covered. N_2 fixation rates were generally extremely small in this area. Predominant blue-green was *Coelosphaerium* - a nonfixing genus. Surface samples only.

During the *Researcher* July 17-19 cruise, N_2 fixation rates were again quite low for most of the stations sampled. Measurable rates of 0.9 and 1.2 nmoles N_2/liters lake water/hour were recorded for stations 98 and 101, respectively.

During the August 1-17 cruise aboard the Oswego *T-501*, N_2 fixation rates ranging from 0.1 to 1.2 nmoles N_2 fixed/liters lake water/hour were observed in the Mexico Bay area. West of Oswego rates were very low. Predominant fixer was *Anabaena flos-aquae*.

During the *Advance II* August 15-17 cruise covering the eastern end of the lake, very low rates were found at most stations. At stations 43, 44, and 74, rates were 0.4, 0.3, and 1.8 nmoles N_2 fixed/liters lake water/hour, respectively. Predominant N_2 fixer was *Anabaena flos-aquae*.

Based on this study it can be argued that orthophosphate is an important nutrient as regards N_2 fixation. Significant N_2 fixation rates were always accompanied by significant orthophosphate levels (>5 µg PO_4/liter). The converse was not true, however. When these rates are expressed in

terms of mg organic N and mg PO_4, a relationship emerges suggesting that significant N_2 fixing activity and the algae associated with this activity are responsible for orthophosphate depletion of the water. This leads to the possibility that phosphorus is limiting in Lake Ontario as regards N_2 fixation.

5. *Profile Mast and Tower Program*

Principal Investigator: J.A. Businger - University of Washington

Final preparations were made for the field experiment in October. During the last 2 weeks of September all equipment was transported to the site and set up for measurements. We had a complete flux- and profile-measuring system on the tower near Rochester and only a profiling system on the Cobourg side. Data were collected during all active periods from October 7 to 15.

All activities planned for the quarter were carried out. The earlier problem of possible interference with the Texas Instruments System was resolved. It was decided to have a separate tower, located about 300 m offshore in the same area, instead of using the TI tower. All equipment was transported to the site in a truck and a house trailer. It took somewhat longer than anticipated to set up instruments on the tower, to lay out cables, and finally to get everything running. Consequently, our data collection was delayed by about 1 week. During that week, only 2 days were considered good for air-mass modification.

6. *Status of Lake Ontario Fish Populations*

Principal Investigator: J.F. Carr - Great Lakes Fisheries Laboratory, Bureau of Sport Fisheries and Wildlife, Department of the Interior

Cruises VI (July 18-August 3) and VIII (August 29-September 14), each a 15-day study of the composition, distribution, and relative abundance of fish species inhabiting the open waters of Lake Ontario, were completed by the R/V *Kaho*. The surveys are being made in cooperation with the Ontario Ministry of Natural Resources and the New York Department of Environmental Conservation. Samples of fish, water, and bottom material were also collected for various laboratory analyses by participating agencies. Cruise reports describing areas sampled and fishing results have been circulated to IFYGL participants. With four assessment fishing studies now done, the *Kaho* has been able to complete all scheduled sampling operations. The final assessment fishing study will take place in October (Cruise X, October 10-26). The *Kaho* will depart for its base at Saugatuck, Mich., on November 1.

7. *Material Balance of Lake Ontario*

Principal Investigator: D.J. Casey - EPA

Collection of stream chemical data is on schedule. No problems have as yet developed; however, with the onset of winter the regular sampling schedules probably will be altered. The Niagara River is being sampled every 3 days, the Black and Oswego Rivers every 2 days, and the St. Lawrence every 3 days.

8. *Runoff*

Principal Investigator: L.T. Schutze - U.S. Army Corps of Engineers

First-cut estimate has been made of monthly runoff from U.S. land area provisional daily discharge records furnished by the U.S. Geological Survey. Analysis of runoff data has not begun because water balance data were incomplete. Data for runoff from the basin in Canada are incomplete, and evaporation data are not available. Methods of extrapolating discharge data over ungaged areas need to be verified by discharge measurements at the mouth of important tributaries.

9. *Evaporation (Lake-Land)*

Principal Investigator: L.T. Schutze - U.S. Army Corps of Engineers

First-cut estimate of April evaporation was prepared and sent to IFYGL Panel Chairmen, Steering Committee Members, and Program Coordinators. Provisional monthly data through August were compiled for lake inflow, outflow, and storage; through July for precipitation and groundwater.

10. *Simulation Studies and Analyses Associated With the Terrestrial Water Balance*

Principal Investigator: B.G. DeCooke - U.S. Army Corps of Engineers

Investigation has not begun.

11. *Land Precipitation Data Analysis*

Principal Investigators: L.T. Schutze and R. Wilshaw - U.S. Army Corps of Engineers

Investigation has not started.

12. *Transport Processes Within the Rochester Embayment of Lake Ontario*

Principal Investigator: W.H. Diment - University of Rochester

Twenty Richardson current meters and temperature recorders that sample for 30 sec every half hour for a period up to 6 months have been installed in the embayment. These devices will be retrieved in late October and will furnish the basic information for determining currents at depths of 10 m and below. Processing and analysis of these data constitute a large part of the proposed work.

A series of "synoptic" (1 day) surveys designed to catch the embayment in its various modes have been conducted. These surveys indicate that water quality in the embayment is dominated by the plume of the Genesee River, which is carried either east or west depending on the wind and which flows out in a thin ($\sim$ 2 m) sheet over the lake water or forms interflows in the epilimnion or in the thermocline, depending primarily on the relative temperatures of the river and lake waters. No further field work of this type is proposed at this time.

A series of drogue observations were begun to better define surface currents. This work will be continued through the fall and will be resumed in the spring on a limited scale.

An intensive (daily) study was made of the embayment for the first week in July in cooperation with Jon Scott (SUNY-Albany), who measured currents and temperatures with depth along four lines in the embayment. We measured other physical and chemical parameters with depth for the inner two lines, as well as on surface samples from the outer two lines. The combined data sets represent the most detailed description of the embayment available.

A study of the nearshore zone was conducted in cooperation with the Monroe County Health Department at 10 stations from July 18 to September 11. The Department measured concentrations of bacteria (total coliform, fecal coliform, fecal streptococcus); we measured several physical and chemical parameters. EPA also sampled the nearshore zone for bacteria during July 24-30 and August 25-31. These nearshore experiments, and a detailed sampling of the embayment on June 19, should give some idea of the distribution of bacteria in relation to other parameters. No further work is planned at this time.

We acquired aerial photographs (vertical) that had been obtained in the past (six times since 1961) by various organizations and obtained three sets of oblique photographs (black and white and Ektachrome) during the summer. The photographs nicely outline the configuration of the Genesee plume (high turbidity) for several wind histories. Aside fro analysis of plume shapes in terms of wind histories, no further work is proposed.

Preliminary results were obtained from a numerical model of the wind-driven circulation. A computer program has been written for solving equations for the steady-state wind-driven circulation, under the assumption that the embayment is vertically homogeneous and the vertical eddy viscosity is constant. Results are in the form of contoured maps of the vertically integrated mass flux, and velocity vector maps for any depth. These results will be compared with velocity measurements collected in the field.

13. *Soil Moisture and Snow Hydrology*

Principal Investigator: W.N. Embree - U.S. Geological Survey

Soil moisture data are being collected on a monthly basis from the 11 active sites in the Black River Basin. Analysis of soil moisture data provides a monthly depth-weighted amount of water in storage for use in determining monthly changes in soil moisture for the basin.

14. *Boundary Layer Structure and Mesoscale Circulation*

Principal Investigator: M.A. Estoque - University of Miami

Observations were made from June 10 to 24. The next observation period is planned for October 1 to 14.

15. *Mesoscale Simulation Studies*

Principal Investigator: M.A. Estoque - University of Miami

Activities consisted of the formulation and preliminary coding of a primitive equation model to be used for simulating mesoscale disturbances induced by Lake Ontario and as a vehicle for testing methods of parameterizing boundary layer fluxes in terms of mesoscale circulations.

16. *Lake Level Transfer Across Large Lake*

Principal Investigator: C.B. Feldscher - LSC/NOAA

Installation of water level gages required for this task, including special pressure-activated gages off Braddock Point and Point Petre, was completed in early July. Meteorological data obtained from the shallow water tower off Braddock Point in July and concurrent water level data from a gage on that tower, the nearby pressure gage, and a gage on a dock near the shoreline were used for a preliminary study in an attempt to determine whether high winds caused a measurable slope in the water surface between the tower and shore gages. No conclusions were reached. Water level data were exchanged between Canadian and United States investigators.

17. *Nearshore Ice Formation, Growth, and Decay*

Principal Investigator: A. Pavlak - General Electric Company

The experiment has been designed, and major hardware items have been fabricated. Deployment of major hardware items (offshore thermistor strings and ground probes) is anticipated during the week of October 31, weather permitting. The data processing package has been designed, and fabrication is proceeding. Deployment of the data-processing package and the start of data acquisition is expected during mid-November.

18. *Advection Term - Energy Balance*

Principal Investigator: J. Grumblatt - LSC/NOAA

Collection and reduction of digital water temperature data at the Lewiston and Cape Vincent, N.Y., stations is continuing. Computer printouts of hourly and daily mean temperatures at these stations are now available. Field measurements of the thermal and velocity structure of the St. Lawrence River in the Wolfe Island and Clayton-Gananoque area in late June and late August are being reduced and analyzed.

19. *Occurrence and Transport of Nutrients and Hazardous Polluting Substances in the Genesee River Basin*

Principal Investigator: L.J. Hetling - New York State Department of Environmental Conservation

The stream sampling program began on July 20, 1972. Samples are being taken every other week. The streams are gaged by the U.S. Geological Survey at the time the samples are taken. In addition to the 15 analyses performed routinely on each of the biweekly samples, additional samples were collected on September 2, 1972, for analysis of mercury, cadmium, zinc, lead, copper, nickel, manganese, chromium, and fluorides, and for screening of the following pesticides: P, DDT, P, DDE, gamma BHC, Methoxychlor, Dieldrin, and Malathion. If any of the above show significant concentrations, we will track down the sources.

The Division of Laboratories and Research, New York State Department of Health, is altering its methods of analyses for Kjeldahl nitrogen and orthophosphates to yield greater sensitivities to agree with the other laboratories participating in IFYGL.

Because of the June flood, the stream in the forest area was drastically altered. Gravel from the banks completely filled the stream bed. Some water flowed over the gravel, and some traveled underneath. In the sampling area, the stream seemed dry on August 24, but some flow was observed coming from below the gravel downstream from the sampling point. On September 7, the stream seemed completely dry. On September 21, the stream bed had been dozed out and the gravel dozed back along the banks. There was some flow.

On October 5 at East Valley Creek, in the forest-brushland area, there was high turbidity due to restoration work on the stream bed 2 mi upstream.

The biweekly sampling program will continue during the next quarter. During that period, the laboratory expects to be up to date with their analyses. As before, samples will be sent biweekly to G. Fred Lee.

A literature search has also been started.

20. *Boundary Layer Flux Synthesis*

Principal Investigator: J.A. Almazan[1] - CEDDA/NOAA

A pilot study based on the U.S. meteorological buoy data is in progress. The purpose of the study is twofold. First, the quality of the data available for analysis are being examined, problem areas are being noted, and recommendations will be made to improve the quality of the data set. Second, a "quick-look" analysis of a 2-week period of buoy data is underway, which includes the computation of heat, momentum, and moisture surface fluxes by bulk aerodynamic formulae. A synoptic analysis of the data is also in progress.

21. *Hazardous Material Flow*

Principal Investigator: N.A. Jaworski - EPA

No report.

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[1] J.A. Almazan has replaced J.Z. Holland as Principal Investigator on this task.

22. *Remote Measurement of Chlorophyll With Lidar Fluorescent System*

Principal Investigator: H.H. Kim - NASA

An airborne laser fluorometer, used for determining surface chlorophyll A distribution, was flown daily along the midtransectline of Lake Ontario (IFYGL Water Quality Stations Nos. 59-49) during the week of October 2-6, 1972. This NASA instrument was also tested for the mapping exercise of nearshore chlorophyll A distribution near Rochester harbor.

Preliminary analysis of the return signals indicates that the system can measure the surface chlorophyll A distribution rapidly. The real-time return signal of a transectline scan shows relatively higher readings along the United States shore than in midlake or on the Canadian side. During the nearshore mapping exercise, a dip in the chlorophyll A density was discovered in the area of approximately 30 m^2 between Rochester harbor and Braddock Point.

Although comparable ground-truth data have not yet been made available, the overflights could mark the first successful operation of an airborne laser fluorosensor for hydrographic purposes.

23. *Inflow/Outflow Term-Terrestrial Water Budget*

Principal Investigator: I.M. Korkigian - U.S. Army Corps of Engineers

Discharge measurements at Massena Point below the powerhouses on the St. Lawrence River, undertaken for the St. Lawrence River Board's River Gaging Committee in cooperation with Water Survey of Canada, have been reduced and a draft report of the results has been submitted to the Committee members. The results can be applied in assessing the use of power plant discharges for determining Lake Ontario outflow. The United States field party, working near Iroquois Dam on the St. Lawrence River, and the Canadian field party, working on the Lower Niagara River, conducted simultaneous measurements of Lake Ontario inflow-outflow during July. Concurrently, crest readings were being taken at the weir on the Oswegatchie River in Ogdensburg, N.Y., together with discharge measurements, to determine the Oswegatchie's flow during the inflow-outflow measuring period. Reduction of the data is nearly complete.

24. *Use of an Unsteady-State Flow Model To Compute Continuous Flow*

Principal Investigator: I.M. Korkigian - U.S. Army Corps of Engineers

Work has not begun.

25. *Radiant Power, Temperature, and Water Vapor Profiles Over Lake Ontario*

Principal Investigator: P.M. Kuhn - ERL/NOAA

Work was completed on June 30, 1972.

26. *Algal Nutrient Availability and Limitation in Lake Ontario*

Principal Investigators: G.F. Lee, N. Sridharan[2], and W. Cowen - University of Wisconsin

Samples of the major tributaries to Lake Ontario have been tested for nutrient limitation by the standard PAAP test and by C-14 uptake tests with nutrient spikes. Tributary water has also been incubated darkness to follow the mineralization of nitrogen and phosphorus. Chemical extractions and equilibrations with anion exchange resins have been used to predict phosphorus availability in the tributary streams. *Cladophora* samples were collected from Toronto, Rochester, and Oswego for use in mineralization tests designed to estimate the extent of nutrient regeneration after death of the algae. Some data on the phosphorus and nitrogen nutritional status of Lake Ontario *Cladophora* have been obtained, but no definite assessment can be made until a more intensive sampling program is established. Future plans include alum treatment of lake water to study the effect of phosphorus removal on the growth of natural lake algae.

27. *Wave Studies*

Principal Investigator: P.C. Liu - LSC/NOAA

Three waveriders near U.S. buoys 14, 19, and 20 were in operation at the beginning of this quarter. The waverider near buoy 17 was put in operation in July. In August, the waverider near U.S. buoy 20 was damaged beyond repair and replaced by the waverider originally deployed near U.S. buoy 12, which has an unsolved interference problem in recording. All four waveriders were recording continuously at the end of this quarter.

Selected periods of wave data recorded from the four waveriders were analyzed on the UA-10 Spectrum Analyzer and 1010 Spectrum Averager. The results will be used for later detailed studies.

Wind and wave data from multichannel recordings on the research tower were not analyzed due to the delayed operation of the analog-to-digital converter at the Lake Survey Center.

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[2] N. Sridharan has been added as a Principal Investigator on this task.

28. *Cloud Climatology*

Principal Investigator: W.A. Lyons - University of Wisconsin, Milwaukee

Camera problems have resulted in continued low percentage of planned data collection, but partial solution to these problems has been found. Solarimeter traces are now being taken at Griffiths AFB, Rome, N.Y., and near Hamilton Beach State Park, N.Y. Twice-daily cloud panoramics continue to be taken by the *Martin Karlsen* and *Limnos* in midlake with good results.

After a 3-month delay, the Rochester 35-mm all-sky camera was installed at Hamilton Beach State Park, along with a Kipp solarimeter. It appears to be functioning well. Repairs on the 16-mm all-sky Bolex camera are now complete,and Scarborough should return to operation. The water-ruined 35-mm system at Peterboro has been repaired and should be operational by mid-November. In the lake, cloud panoramics will continue to be taken by the ships. There have been some problems with the Oswego camera's cooling system and film advance, but the camera will hopefully be fully operational shortly. The Nikon equipment at McMaster University is still completely fouled up ; two cameras are now being repaired.

29. *Zooplankton Production in Lake Ontario as Influenced by Environmental Perturbations*

Principal Investigator: D.C. McNaught - State University of New York at Albany

The vital inshore waters of eastern Lake Ontario are being examined by limnologists from SUNY-Albany with regard to zooplankton production. Initial analysis of 1,000 samples, collected at 45 stations from May through September 1972, indicates the vital role that rotifers have in this community. Rotifer abundance for single genera (13) reach 86,300/m^3. Such high productivity may be tied to inshore pollution. Future analysis will lead to the development of models useful in pinpointing areas of pollution in the coastal waters of Lake Ontario.

A large number of samples have been processed. The planktonic rotifers are an important segment of this inshore community; they may be excellent indicators of environmental perturbations.

The mean numbers per cubic meters given below are evidence of the abundance of such forms.

Genera	Range - number/m^3
(1) *Keratella*	300 - 32,900
(2) *Kellicottia*	800 - 3,000
(3) *Brachionus*	76 - 2,670
(4) *Polyarthra*	350 - 47,400

Genera	Range - number/m^3
(5) *Synchaeta*	100 - 86,300
(6) *Notholca*	70 - 2,400
(7) *Filinia*	800 - 1,100
(8) *Asplachna*	800 - 6,400
(9) *Conochilus*	400 - 1,000
(10) *Chromogaster*	<150
(11) *Ascomorpha*	<150
(12) *Gastropus*	<150
(13) *Ploesoma*	<150

30. *Change in Lake Storage Term - Terrestrial Water Budget*

Principal Investigator: R. Wilshaw - U.S. Army Corps of Engineers

A total of 23 shore and tower gages are now in operation. No further progress has been made toward the completion of the computer program for data analysis. It is anticipated that some initial correlations should be made before the end of this quarter.

Water-level gage installations were completed on the Olcott and Braddock Point offshore towers. An additional shore gage and a tower pressure gage were installed at Braddock Point. Data from these gages began to be received in July. There are now 15 recording gages on the United States side and eight on the Canadian side of Lake Ontario.

31. *Soil Moisture*

Principal Investigator: L.T. Schutze - U.S. Army Corps of Engineers

No report.

32. *Testing of COE (Corps of Engineers) Lake Levels Model*

Principal Investigator: E. Megerian - U.S. Army Corps of Engineers

Work on this task will start around April 1973.

33. *Near-Shore Study of Eastern Lake Ontario*

Principal Investigator: R.B. Moore - State University of New York at Oswego

During this quarter, 155 river and lake sample stations were occupied. Besides samples for temperature profiles, dissolved oxygen, alkalinity, depth and light penetration, samples were collected for other analyses. All water samples were transported to the EPA Rochester

Field Station for analysis. The remaining samples have been preserved chemically or frozen for analysis in Oswego and Albany.

Samples		Number
Collected for:		
(1) Trace metals analysis		342
(2) Soluble nutrients		618
(3) Total nutrients		462
	Subtotal	1,422
Collected for:		
(1) Chlorophyll determinations		456
(2) Phytoplankton analysis		426
(3) Zooplankton analysis		522
(4) Benthic analysis		188
(5) Sediment chemistry		35
(6) *Cladophora* biomass		93
(7) Phytoplankton biomass		280
	Subtotal	2,000
	Total this quarter	3,422

In addition, (1) *Cladophora* samples were collected for the University of Wisconsin project, and laboratory space was provided for some of t work, (2) ground-truth data were collected for the Willow Run Laboratory's *Cladophora* overflights, and (3) the *LOTEL* research vessel participated in two intercomparisons to check on reproducibility of data collected by different groups.

All late spring benthic samples have been picked, stained, and mounted on slides. Identification is proceeding and taxonomy of organisms is being correlated with the Great Lakes Laboratory, which is responsible for the benthos for the western nearshore program. Type specimens of each species are being selected for interchange with other laboratories.

Analysis of *Cladophora* and phytoplankton samples for chlorophylls A, B, and C and phaeophytin A is proceeding. *Cladophora* samples have been analyzed for dry weight, wet weight, and ash weight. Samples are

being held for chemical analysis of carbon, nitrogen, phosphorus, and silicon. Glass-fiber filters accumulated during collection of water samples are being analyzed for chlorophylls A, B, and C, phaeophytin A, and plant and animal carotenoids.

34. *Internal Waves - Transects Program - Interpretation of Whole-Basin Oscillations*

Principal Investigator: C.H. Mortimer - University of Wisconsin, Milwaukee

During this period, data were gathered during two cruises (July 24-28 and August 7-11) on Lake Ontario. Two ships were used for each cruise, NOAA's *Researcher*, and Cape Fear Technical Institute's *Advance II*. The undulating temperature/depth measuring system developed by the Center for Great Lakes Studies was carried on the *Researcher*, and mechanical BT's were used from the *Advance II*. During the 4-day cruises, the *Researcher* steamed continuously back and forth along a line between Braddock Point, N.Y., and Presqu'ile, Ontario. The *Advance II* followed a route between Oswego, N.Y., and Prince Edward Point, Ontario.

Undulator Data Reduction - The digital data tapes from the undulator deck electronics were returned from Lake Ontario to Milwaukee and processed to flag obviously bad data and to compress the information. The processing program writes first on magnetic drum storage, which is then transferred to permanent storage on magnetic tape via the program TAPE UTILITY. The compact processed tapes are subdivided into separate "files," each containing the information derived from one deck tape. A file will therefore contain the data from several transects. Almost all the data taken during the July and August cruises are now in this compact form.

We are now examining the plots and prints of selected sections of the data taken from the compact tapes, and, in order to economize on the computer costs of searching out selected information, we are splitting the compact data tapes into separate files, each representing one transect.

The temperature sensor on the undulator responds rather sluggishly to rapid ambient changes (half-power point $\approx$ 0.013 cps, time constant $\approx$ 5 sec). Because of this lag, and since a typical cycle consists of 1 min for the dive and 4 min for the re-ascent, we are using the data from the ascent only. However, we are also attempting to build a linear regression model of the response, based on laboratory tests and relationships within the field data, so that dives can also be used.

The x-y plots of temperature versus depth, which are produced on board ship at the time of each undulator dive, are being analyzed manually for a quick look at thermocline depth variations.

Mechanical BT Data Reduction - The 650 or so BT slides collected during the two cruises are being enlarged and reproduced through the use of a RECORDAK microfilm reader-printer. The slide is copied together with the appropriate grid, and the depth of selected isotherms are then read off visually and plotted versus position along a mean transect line.

35. *Pontoporeia affinis and Other Benthos in Lake Ontario*

Principal Investigator: S.C. Mosley - University of Michigan

The epibenthic sled apparatus and towing procedures have been modified. The device that measures distance traversed on bottom was modified to operate only when the sled doors are open (i.e., when the sled is on bottom). Pending diver observations of actual function, the performance of this device must be deduced from sample sizes. Processing of samples is not advanced enough to allow evaluation of the success of the modification.

Towing procedures were modified to reduce the clogging of the net with mud. Towing times were reduced and less warp per unit depth was used at certain stations.

Despite reductions in other operations of the R/V *Kaho*, she has continued to occupy all epibenthic sled stations at or near scheduled times. Extra sets of samples have been obtained from several transects, especially the Mexico Bay transect off Nine-Mile Point. Four additional stations have been occupied in the shallow eastern basin.

More detailed tests of the Folsom plankton sample splitter have affirmed its randomness of operation for the full size range of *Pontoporeia affinis*. With the aid of University of Michigan statistical services, precision tables have been constructed for estimates of total or group abundance, depending on the number of successive splits and the total number of specimens counted in the subsamples.

A total of 72 samples have been fully processed. *Mysis relicta* has been sorted from all processed samples and sent to J.R. Reynolds of the University of Missouri for detailed study. This animal shares with *Pontoporeia* the role of most important food for many Lake Ontario fishes.

A 2-day special cruise has been arranged for November off Oswego and Cobourg aboard the *Advance II*.

36. *Pan Evaporation Project*

Principal Investigator: T.J. Nordenson - NWS/NOAA

The observation program at all six evaporation stations has proceeded satisfactorily. Class A pan observations will be discontinued about November 1, 1972, due to cold weather. It is proposed to install heating elements in the X-3 pans to prevent freezing and permit winter operation. The amount of heat added will be measured, and by the analysis of the pan energy budget values of incident minus reflected all-wave radiation (Qir) will be computed. These Qir values will be used in computing lake evaporation for the winter months.

37. *Simulation Studies and Other Analyses Associated With U.S. Water Movements Projects*

Principal Investigators: J.P. Pandolfo and C.A. Jacobs - CEM

The extensive changes made in the model last quarter were, at first, inconsistent with the physics of an enclosed body of water with a free surface. Major inconsistencies were the nonconservation of mass manifested in the choice of an improper finite-difference scheme for computing the divergence and too large a time lag between the computation of the pressure (water surface height) term and its application in the momentum equation. The first problem was easily corrected, but the second required extensive reprogramming, resulting in a model that takes considerably longer to execute on the computer. This model, which will be referred to as the "free surface" model, costs about $700 in computer funds to simulate 1 day for a hypothetical "box" lake and surrounding land depicted by 36 horizontal grid points (6 x 6 array), with 25 vertical grid points associated with each horizontal point. Because the running cost of the free surface model is clearly prohibitive at this time, a second version of the model was developed in which the pressure term is prescribed rather than predicted. This model is referred to as the "rigid lid" model and eliminates any problems associated with the coupling of the pressure and momentum equations. The rigid lid model damps gravity waves in the solutions for the air and water layers, a sacrifice for a faster running computer program.

After 4 hours of simulation, the solutions with the "free surface" model in the box lake contain gravity waves with periods on the order of 1 hour, wavelengths of 80 km, and amplitudes of less than 10 cm. The theoretical period of the seiche for the box lake is 34.8 hours, and the waves that appear in the solutions of the free surface model are therefore of relatively high frequency. It would be difficult to verify the existence of these gravity waves since their amplitudes are small and the associated oscillatory currents are of the order of a few centimeters per second.

The rigid lid model will be used to meet task milestones. Once the milestones have been met, the investigation of the "free surface" model will be resumed, if resources permit.

38. *Tower Program*

Principal Investigator: H.A. Panofsky - Pennsylvania State University

Observations of wind speed fluctuations have been completed for 37 1-hour runs at two levels on three masts near Niagara bar. All analog tapes are now being converted to digital format on the hybrid computer, Department of Electrical Engineering, Pennsylvania State University. First, paper charts for only two runs will be transferred to digital tape on the Calma machine, and the two sets of digitized runs will then be compared. If the comparison turns out to be satisfactory, the remainder of the strip charts will be processed only in an emergency, because this procedure is laborious. Instead, data primarily from the 24 analog tapes, six anemometers each, will be analyzed.

39. *Airborne Snow Reconnaissance*

Principal Investigator: E. Peck - NWS/NOAA

No flights were scheduled or flown during the quarter. Plans are complete for background calibration flights to be flown for all survey lines during October. The National Environmental Satellite Service will have other remote sensing surveys at the same time for evaluation of the sensors for measurement of soil moisture. The ground-truth information for both the June background calibration flights and the background flights scheduled in October will be published in a single report.

40. *Optical Properties of Lake Ontario*

Principal Investigator: K.R. Piech - Cornell Aeronautical Laboratory

During this reporting period, principal activities were both ship and aircraft data collection. Three cruises and the initial three aerial overflights were completed. Processing, logging, and initial calibration of the imagery have been done. Three cruises and three aerial overflights, the latter to complete the aerial data collection program, are planned for the next reporting period (August 15 to November 15). One data gathering cruise remains for the period after November 15.

The *Researcher* measurements consist of Secchi disk readings, transmissometer measurements of total attenuation, and measurements of upwelling and downwelling irradiance. Cruises were undertaken by the *Researcher* during the weeks of May 23, June 12, and July 10. The cruise originally scheduled for the week of May 15 was rescheduled for May 23 because of lack of space on the ship.

Data collection proceeded essentially as planned, with minor data losses caused by equipment malfunction. Weather conditions were mostly clear during the cruises beginning May 23 and July 10; the week of June 12 was overcast. Approximately one-half day of relative irradiance data was lost on June 15 because of condensation in the transmissometer optics, a condition that was corrected for the remainder of the week. The relative irradiance system malfunctioned from July 13 in the afternoon through July 14, which necessitated extensive repairs. These have now been completed.

Preliminary reduction, analysis, and correlation of the *Researcher* data are being undertaken by means of a computer plotting program.

Lake turbidity is also being measured from aircraft by means of photographic photometry. These measurements will allow comparison of aerial and cruise turbidity measurement techniques, as well as a more thorough and extensive areal estimate of turbidity variations. The flight path consists of four transects across the lake at 10,000 ft along the north-south lake station lines that include master water quality stations 10, 22, 41, and 67 (denoted as tracks 1 to 4, respectively). The initial and final track points are: track 1, Welland Canal and Woodbine racetrack; track 2, Olcott Lighthouse and Gold Point; track 3, Troutberg and Club Point; and track 4, Sodus Bay Maime Standard and Prince Edward Point. Additional shoreline imagery is also being obtained.

Aircraft overflights were made on June 16, June 27, and July 17. On June 16, the flight was aborted after completion of tracks 1 and 2 due to heavy cloud conditions over the northern portions of the lake. The flights on June 27 and July 17 were completed, weather conditions being much more favorable.

Shoreline shadow densitometry is being used to obtain skylight and sunlight irradiance, air light radiance, and atmospheric transmission effects. Densitometry of lake imagery then yields lake volume reflectance. Since densitometry is being performed for each of the three layers of the multispectral film, direct comparison with the cruise measurements made with the Wratten filters will be possible.

The imagery from the three flights has been fully logged and examined for unusual turbidity variations, slick conditions, or wave patterns indicating the presence of interfacial films. Initial sensitometry has been done for all three dates, and calibration of June 16 completed for the unpolarized imagery. This calibration and the qualitative logging have confirmed the importance of the photometric calibration of atmospheric effects in evaluation of lake turbidity.

41. *Storage Term - Energy Balance Program*

Principal Investigator: A.P. Pinsak - LSC/NOAA

No report.

42. *Sensible and Latent Heat Flux*

Principal Investigator: A.P. Pinsak - LSC/NOAA

No report.

43. *Thermal Characteristics of Lake Ontario and Advection Within the Lake*

Principal Investigator: A.P. Pinsak - LSC/NOAA

No report.

44. *Oswego Harbor Studies*

Principal Investigator: A.P. Pinsak - LSC/NOAA

Data collection has been completed as scheduled on 33 cruises between May 1 and November 10, 1972. The general program and parameters measured are described in IFYGL Technical Plan, Volume I, section 5.3.1.6 pp. 251-256. Water analyses are complete except for the last four cruises between November 7 and 10, and most of the data have been reduced by computer.

Sediment analyses have not been completed. Required input is outlin in the Technical Plan, Volume I,under Activity 3, p. 253. The chemical and physical data, including daily flow rates of the Oswego River and the temperature and volume of cooling water flowing into the harbor from the power plant will be essential to finishing the program as outlined. No additional field work is contemplated since the harbor has been sampled under a wide range of conditions.

Shipboard chemistry data are available in computer listings with weighted means for each parameter at each station.

Ion data from the shore-based laboratory will not be available until all analyses have been done, after which the totals will be treated statistically.

45. *Mapping of Standing Water and Terrain Conditions With Remote Sensor Data*

Principal Investigator: F.C. Polcyn - University of Michigan

Progress is impeded by the lack of ERTS-1 data. To date, no ERTS imagery or data tapes have been received for analysis. While ground support and aircraft data collection have proceeded on schedule, no complementary satellite data are available. Haze conditions during periods of aircraft data collection and ERTS overpasses may have somewhat degraded the quality of remote sensor data obtained during this reporting period. A multispectral remote sensor mission planned for the week of August 1-5 was postponed to September 7 because of low visibility resulting from atmospheric haze over much of the Lake Ontario Basin.

On June 17 and 18, new multispectral remote sensor data were collected by C-47 aircraft of the University of Michigan's Willow Run Laboratories over hydrological study areas in or adjacent to the Lake Ontario Basin. On these flights, approximately 110 mi were flown over terrestrial areas.

Multispectral data were collected with University of Michigan's new M-7 optical-mechanical scanner system. This scanner became operational in the summer of 1971 and provides complete registration and full 90° field of view for all data channels. The 12 spectral bands are listed as follows: 0.41-0.48 μm (violet), 0.48-0.52 μm (blue), 0.50-0.54 μm (green), 0.52-0.57 μm (yellow-green), 0.55-0.60 μm (yellow), 0.58-0.64 μm (orange), 0.62-0.70 μm (red), 0.67-0.94 μm (near-infrared), 0.71-0.73 μm (near-infrared), 1.5-1.8 μm (mid-infrared), 2.0-2.6 μm (mid-infrared), 9.3-11.7 μm (thermal infrared). Video playback of four selected channels indicates that the multispectral data are of good quality. In addition to the data channels listed, sun sensor, thermal reference plates, and references lamps were also recorded.

Four cameras were used in collecting aerial photographic data of the study areas: 70-mm color, false color, black and white IR film, and 9-in. panchromatic film. The false color positive transparencies are of good quality. The positive color film appears to have a reddish-orange cast, possibly due to improper film development. All original film will be supplied to NASA's Manned Spacecraft Center in Houston, which will make copies available.

Upward- and downward-looking pyronometer data were recorded during each of the flights. These data will be reduced and correlated with the calibrated scanner data for energy budget determination.

Three sites were selected for the development and testing of remote sensing techniques for application to terrestrial hydrological studies. Both dawn and midday multispectral data were obtained from two of the sites.

46. *Remote Sensing Program for the Determination of Cladophora Distribution*

Principal Investigators: F.C. Polcyn and C.T. Wezernak - University of Michigan

Multispectral and photographic coverage was obtained July 31, 1972, by the Willow Run Laboratories' remote sensing aircraft from an altitude of 2,000 ft. Data were collected along the U.S. shore from Niagara to Stony Point at the eastern end of the lake. Scanner and photographic data collected on this mission and on the earlier flight on June 20 are being processed. Computer processing of the data has begun. Work in the next quarter includes continued data processing of selected sections for purposes of calculating the areal distribution of *Cladophora*.

47. *Remote Sensing Study of Suspended Inputs Into Lake Ontario*

Principal Investigators: F.C. Polcyn and C.T. Wezernak - University of Michigan

No report.

48. *Island - Land Precipitation Data Analysis*

Principal Investigator: F.H. Quinn - LSC/NOAA

Precipitation data were collected continuously at the six Lake Ontario stations. Data tapes covering the period up to April 13 were reduced. Tabulated precipitation data are now available for 1971. The data collection and reduction programs are on schedule.

49. *Lake Circulation, Including Internal Waves and Storm Surges*

Principal Investigator: D.B. Rao - University of Wisconsin, Milwaukee

No report.

50. *Atmospheric Water Balance*

Principal Investigator: E.M. Rasmusson - CEDDA/NOAA

The field phase of this program began on September 16. Two rawinsonde observations per day at each of the six stations were originally scheduled for September 16 through September 21. Four ascents from each station had to be cancelled between September 19 and 21, however, because of shutdown of one of the Loran stations. Intensive observations - eight ascents daily - were made during a shakedown period between September 22 and 26, after which the twice-daily soundings were resumed.

Problems encountered were discussed by both United States and Canadian representatives at two meetings, one held at CEDDA, Rockville, Md., on September 22, and the other at U.S. Field Headquarters, Rochester, N.Y., on September 30. The most serious problem, and one for which no adequate solution has yet been found, arises from the frequency drift of the LOCATE system, which causes the rawinsonde receiver to pick up the signal of another rawinsonde rather than its own.

Data processing to date has been limited to "quick-look" review and microfilm output for preliminary determination of data quality.

51. *Evaporation Synthesis*

Principal Investigator: E.M. Rasmusson - CEDDA/NOAA

A 2-week period in July has been chosen for a pilot study. Data to be examined are wind speed and direction, air and lake surface temperature, and dew point. Target date for completion of the study is early 1973. Our strategy for computing parameters used in the calibration of the mass transfer equation will be largely determined by the results of this study.

52. *Ground-Water Flux and Land Storage*

Principal Investigator: E.C. Rhodehamel - U.S. Geological Survey

Preliminary analysis indicates that about 100 cfs is contributed to Lake Ontario through ground-water inflow from the upstream side.

A tentative report outline has been prepared. A literature search was conducted to gain additional data on the hydraulic properties and hydrogeologic nature of the lake-front materials. The Darcy equation and base-flow analysis techniques were applied to data for selected areas for a check on methods of analysis.

53. *Spring Algal Blooms*

Principal Investigator: A. Robertson - IFYGL Project Office/NOAA

Sample analysis is proceeding as planned. Data analysis has not begun.

54. *Ice Studies for Storage Term - Energy Balance*

Principal Investigator: F.H. Quinn - LSC/NOAA

Collection and reduction of solar radiation and wind speed and direction data from the Mexico Bay meteorological station is continuing. A computer program for data presentation and analysis is nearing completion. The air and water temperature system, damaged during a storm in early August, was removed for repairs.

55. *Lagrangian Current Observations*

Principal Investigator: J.H. Saylor - LSC/NOAA

Current patterns were measured in the western third of Lake Ontario during mid-July to mid-August. The studies were conducted primarily in the deep-water, central portion of the lake basin. During the second half of September, current patterns were charted in the eastern third of the lake basin, again in the central part of the lake. Currents were measured mainly by tracking the drift of a network of drogues.

Data collection progressed as planned. During the July-August period in western Lake Ontario the flow patterns were strongly baroclinic and always in nearly geostrophic equilibrium. September observations showed rotational currents of near-inertial period to dominate in the eastern part of the lake.

56. *Circulation of Lake Ontario*

Principal Investigator: J.H. Saylor - LSC/NOAA

Because all Water Motion Branch personnel are involved in field programs, only cursory examination of the current meter records have been made. Some comparative measurements of currents in vicinity of the U.S. buoys have been compiled for use in data verification.

Several factors account for the divergence between plan and progres All data collected by the lake buoys have not been stored in real time in the LSC computer. There are additional data to be inserted in the

data files from the cassette recorders used on some buoys and from RCC tapes for periods when the computer was off line. Also, the real-time data have not been processed through final calibration filters.

57. *Phytoplankton Nutrient Bioassays in the Great Lakes*

Principal Investigator: C. Schelske - University of Michigan

No activity.

58. *Runoff Term of Terrestrial Water Budget*

Principal Investigator: G.K. Schultz - U.S. Geological Survey

Peak stage marks for the high water in late June were obtained for all gaging sites. A discontinued crest-gage site, Chaumont River near Depauville in the area north of Watertown, N.Y., was added for observations of another representative stream. A low-flow check measurement was made on September 26,and it verified a recent rating. All continuous recording gages were visited during September 26-27. Correlation studies, in which unit runoff of representative areas is used to estimate flow of the ungaged areas, are progressing smoothly and are about one-third complete for all 27 areas. Information was obtained from the New York State Barge Canal Offices to help determine the behavior of the Canal flow.

It has been difficult to reach some of the streams at the proper time to obtain discharge measurements at the desired discharge. Estimating the flow of the Canal into the affected ungaged areas will be a problem, and the accuracy of the results will be less than those of the unaffected areas. Our studies have shown that the values of inflow into Salmon River Reservoir, as computed by the power company, cannot be used for our purpose. The computed inflow values are erratic and frequently show negative inflows. The reservoir releases are being used.

59. *Coastal Chain Program*

Principal Investigator: J.T. Scott - State University of New York, Albany

The second "coastal chain alert" for the period July 15 to August 15, 1972, was more successful than the first alert period, with at least one successful run on nearly 70 percent of the days. The first 15 days of the third alert gave poor results due to a considerable amount of storminess. Our best chain yielded data for only 40 percent of the September 15-30 period. Continuously recorded current measurements were improved over the first alert in terms of length of operation of these meters, but quality of the data will not be known until the meters are recovered and the data are screened.

"Spot" coastal chain measurements went as planned, except that unreliability of the current meters required the use of two backup meters. Our continuously recorded meter programs therefore did not go as planned. We attempted to resolve this for the Rochester chain by requesting two fixed meters from the University of Rochester group headed by W. Diment. These were anchored at our stations 24 and 27 in the second week of July, but will not be removed until late in the year. The raft at Olcott was anchored and much of the data appear to be usable. For the Oswego chain we installed a Braincon Savonius meter and recorder on the Bedford buoy located near our station 8. This gave some data but they may not be usable.

As seen in the table below, the number of days of usable data amounte to about 70 percent of the period, which is perhaps a bit better than normal. Weather was generally more calm than usual, with only two stormy periods causing data loss (July 23-26 and August 7-10). The data bank includes four interesting "natural events," one upwelling being of particular interest.

The "Rochester embayment study," conducted in cooperation with W. Diment's group, should produce some important data, because the study followed Hurricane Agnes by about 10 days. The Genesee river plume was a striking indicator of the flow pattern of the river entering the lake. Our data from four coastal chains within the Rochester region should add significantly to the water quality information obtained by the Rochester group.

Summary of coastal chain data record and causes of unusuable runs for the second alert

	Oswego	Rochester	Olcott
Days of alert	31	31	31
Possible runs	62	62	62
Runs attempted	44	38	42
Usable runs completed	42	31	35
Usable full days completed	19	13	13
Usable days (one or more usable runs)	24	21	23
Unusable runs	20	31	27
Reasons:			
Weather	19	23	19
Fog	0	0	1
Rough sea	19	23	18
Equipment failure	1	6	2
Meters	1	5	1
Boats	0	1	1
Crew	0	2	5

60. *Analysis of Phytoplankton Composition and Abundance*

Principal Investigator: E.F. Stoermer - University of Michigan

The primary objective of this project is an assessment of the abundance and distribution of phytoplankton populations in Lake Ontario during the International Field Year. Aside from the direct implications for water quality assessment, such information is essential to the interpretation of nutrient flux measurements and the eventual construction of predictive models. A secondary but, we think, very important objective of the project is the collection and preservation of archival material to serve as a baseline for comparing future studies. At the present time such information is lacking for Lake Ontario.

All samples used by this project are taken from 60 main lake biology-chemistry stations at standard depths of 1, 5, 10, 15, 20, 25, 30, 40, 50, 100, and 150 m, and 1 m above bottom. Sampling platform for all work to date has been the *Researcher*. Preliminary processing of all samples is done aboard ship. Three types of samples are reduced from all stations and depths: (1) whole phytoplankton samples, which are filtered and reduced to semipermanent microscope slides, (2) archival samples, which are filtered and preserved without further treatment, and (3) particle count samples, which are preserved as whole water samples and returned to the laboratory without further treatment. In addition to the samples taken from all stations, a sample for chlorophyll extraction is taken from master stations.

Whole plankton slides are analyzed by manual counting on an optical microscope. Species present are enumerated and raw counts are reduced through a preliminary program that calculates estimates of volumetric abundance, relative frequency, diversity, and of probable error in the above parameters. Particle count samples are reduced through an optical occlusion particle counter-sizer. The instrument operates in five adjustable channels between 5 and 30 μm in nominal diameter; the output is in digital counts. Archival samples are permanently labeled, sealed, and collated in preparation for deposition in a permanent repository. Chlorophyll concentrations are determined fluorometrically from acetone extracts of cellulose acetate.

The original project plan called for sampling beginning with a cruise in April 1972, but this cruise was canceled because a sampling platform was unavailable. Sampling on the May 1972 cruise was only 50 percent effective due to weather. On subsequent cruises sampling has been over 95 percent effective. Samples are now in hand and preliminary processing has been done for 2,051 of the originally projected 4,000 stations and depths. Because of lack of coverage during the critical spring period in 1972, objectives of this project would be best met by continuing sampling into early spring of 1973. In data reduction to date we have concentrated on analysis of near-surface samples in order to obtain an early estimate of total phytoplankton distribution in Lake Ontario.

61. *Clouds, Ice, and Surface Temperature*

Principal Investigator: A.E. Strong - NESS/NOAA

No report.

62. *Analysis and Model of the Impact of Discharges From the Niagara and Genesee Rivers on Nearshore Biology and Chemistry*

Principal Investigator: R.A. Sweeney - State University College of New York at Buffalo

The sampling schedule was maintained for primary productivity, phytoplankton, zooplankton, benthos, water and sediment chemistry, as well as physical parameters in the nearshore zone from the Welland Canal through Rochester and the Niagara and Genesee River mouths.

Our research vessel, the *Dambach*, also participated in the ship intercomparison on August 18, 1972.

63. *NCAR/DRI - Buffalo Program*

Principal Investigator: J.W. Telford - Desert Research Institute, University of Nevada

The August field trip proceeded on schedule, but several days in the first week were lost because of inertial platform maintenance and poor weather. One good opportunity was lost. From August 19 to 26, equipment was fully operational with the exception of the standard NCAR equipment high data rate backup recorder for recording the microwave refractometer. The high data rate records are therefore not available for this period. This does not affect the winds, momentum, and heat flux but the dew-point hygrometer recordings are probably too slow for adequate vapor flux data.

Data processing was concentrated on updating procedures for the distance-measuring equipment. Much work remains to be done in this area to improve absolute wind velocity measurements. The map of the lake was digitized, and a number of flights were plotted with the wind vector displayed. The magnetic tape has been transposed to strip-chart plots, which is extremely valuable in planning more advanced processing.

64. *Mathematical Modeling of Eutrophication of Large Lakes*

Principal Investigator: R.V. Thomann - Manhattan College

The main emphasis during the second quarter was placed on analyzing the diffusion and transport structure of the proposed lake model. A "preliminary" segmentation with four vertical layers and a total of 40

segments was used to represent the lake. The selection of the number of segments per layer was dictated by bathymetry. Smaller nearshore segments were used in the surface layer to allow some definition of nearshore phenomena, such as "coastal jets". Material inputs from industrial, municipal, and tributary sources were obtained from International Joint Commission (IJC) data. The flow regime was determined from IJC velocity estimates of Lake Ontario circulation at various depth intervals. Chloride concentration is being used as the conservative tracer and is being compared with 1966 CCIW data.

A summary of pertinent data at various depths and times throughout a sample year was prepared and displayed in the form of spatial contours. The waste-loading access program will be expanded when additional information is required. All available STORET data for the area in question have been obtained in punch-card form.

Plans for the next quarter call for continuation of the diffusion and transport model verification. A steady-state model may be implemented if it is found that these solutions would be useful. Preliminary work on the concept of a vertically layered phytoplankton model will be begun. This model will be structured, and debugging will be carried out during the next quarter. Nutrient limitations and predation are to be included. The strategy for the remaining two quarters is to examine the kinetics of phytoplankton behavior (based on CCIW data, and on IFYGL data when the latter become available) with a vertical model and transport structure with a horizontal grid model. STORET data are to be transferred to CDC 6600 compatible tape.

65. *Cladophora Nutrient Bioassay*

Principal Investigators: G.F. Lee and W. Cowen - University of Wisconsin

See Task 26.

66. *Sediment Oxygen Demand*

Principal Investigator: N.A. Thomas - EPA

Measurements of sediment oxygen demand have been completed on Lake Ontario. During cruises in July and August all major sections of Lake Ontario were covered. High oxygen demand rates were found in the eastern sector of the lake. Sediment samples were collected at the time of observation, and scuba divers were used in July to observe the bottom characteristics of Lake Ontario and the operation of the sediment oxygen demand chamber.

67. *Main Lake Macrobenthos*

Principal Investigator: N.A. Thomas - EPA

The collection of samples for determining the distribution and abundance of benthic organisms has been completed. During October, 60 stations were sampled for both benthic organisms and sediment characterization. Sorting and identification of the June samples has begun.

68. *Exploration of Halogenated and Related Hazardous Chemicals in Lake Ontario*

Principal Investigators: G.F. Lee and C.L. Haile[3] - University of Wisconsin

Lake Ontario fish, water, *Cladophora*, plankton, and sediment samples were collected at several nearshore stations around the lake. The plankton and *Cladophora* were divided into samples of approximately 1 g to be extracted by shaking with hexane-acetone azeotrope. The 10-liter water samples were extracted on board the sampling vessel by passage through a column of polyurethane foam plugs coated with DC-200. The plugs were exhaustively extracted (Soxhlet extractor) with hexane-acetone azeotrope and the extracts were cleaned up on florisil, as were the plankton and *Cladophora* extracts, according to procedures developed. Silicic acid procedures for further cleanup have been developed but not yet used.

Fish collected were ground and homogenized while frozen and exhaustively extracted (Soxhlet extractor) in 10-g batches. The extracts were analyzed for fats and cleaned up following previously established procedures. Some of the fish extracts were subjected to GC analysis for p,p'-DDE, yielding values ranging from 0.5 µg/g to 1.3 µg/g on a whole-fish basis. The fats content of the fish ranges from just over 1 to nearly 10 percent.

Sediment samples collected have not been extracted and are being kept frozen until they can be processed. Benthos samples have not yet been received.

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[3] G.F. Lee and C.L. Haile have replaced G.D. Veith as Principal Investigators on this task.

69. *Basin Precipitation - Land and Lake*

Principal Investigator: J.W. Wilson - CEM

The computer program for combining weather radar and rain-gage data was checked out and successfully executed on tropical storm Agnes. This means that all computer programs for processing the radar data are now operational. The results of the rainfall measurements during Agnes were very encouraging and a report describing the results will be prepared.

Generation of the edited raw data set (Data Set 1) and the hourly totals (Data Set 2) is now progressing smoothly. Ten raw data tapes from Buffalo, collected before September, could not be processed because they contained some bad records. It is expected that the necessary computer routines for skipping over the bad records will soon be available.

Malfunction of the magnetic tape recording system at Oswego resulted in the loss of 25 days of collection. However, data for this period were collected on 16-mm film. Provided the Buffalo tapes bad records can be processed, data will have been collected during approximately 80 percent of the time when precipitation occurred within range of the Buffalo radar.

Efforts still continue to obtain better ground-truth measurements of snowfall during the coming winter.

70. *Evaluation of ERTS Data for Certain Hydrological Uses*

Principal Investigators: D.R. Wiesnet and D.F. McGinnis - NESS/NOAA

No report.

71. *Distribution, Abundance, and Composition of Invertebrate Fish - Forage Organisms in Lake Ontario* [4]

Principal Investigator: J.F. Carr - Great Lakes Fishery Laboratory/ BSFW

Collections of invertebrate forage organisms for evaluation of seasonal abundance, composition, and distribution are complete. Samples of the opossum shrimp *(Mysis relicta)*, mixed benthos, including the

[4] This is a new IFYGL task.

burrowing amphipod (*Pontoporeia affinis*), and crustacean macrozooplankton were obtained during three 15-day cruises (May-June, August, September-October) on the research vessel *Kaho*. Two cruise reports (cruises III and VII), dealing with sampling activities and preliminary results, have been circulated to IFYGL participants, and the third and final report (cruise IX) is in preparation.

Emphasis in sampling was placed on transects off Hamilton, Ontario, and Rochester and Oswego, N.Y., where, during alternate fishery cruises, specimens of alewife, smelt, and slimy sculpin were collected for evaluation of food habits. Additional invertebrate samples were collected at transects off Olcott, N.Y., and Cobourg and Point Petre, Ontario.

72. *Coastal Circulation in the Great Lakes*[5]

Principal Investigator: G.T. Csanday - Woods Hole Oceanographic Institution

The objectives of this task, added in September, are to analyze and evaluate the north-shore IFYGL coastal chain data, to compare them with south-shore data; to construct a theoretical model of the coastal boundary layer, taking into account nonlinear and frictional influences; to analyze data on coastal mass exchange episodes associated with current reversals; to construct a theoretical model of the mass-exchange process; and to conduct a theoretical study of secondary circulations in the vicinity of upwellings.

73. *Lake Water Characteristics*[6]

Principal Investigator: A.P. Pinsak - LSC/NOAA

A systematic data collection program is being undertaken in which vertical and lateral distribution, as well as variations with respect to time, of the chemical and physical properties of Lake Ontario and its immediate environment are being measured and analyzed. The project is designed to complement existing data and continuing programs on Lake Ontario. The sampling program will provide basic information necessary to define time-spatial relationships of significant water characteristics in Lake Ontario.

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[5] This is a new IFYGL task.
[6] This is a new IFYGL task.

Chemistry cruises were conducted by the *Researcher* from July 31 to August 4, September 11 to 15, October 16 to 20, and November 13 to 17. Some 60 stations were sampled at multiple levels during each cruise. Analysis of major ions and nutrients is being completed. Data listings will not be available until all analyses are complete, about mid-December 1972.

Project Areas

Boundary Layer

The Boundary Layer Panel has completed four 2-week alert periods. During these intensive periods of observations, in May, June, August, and October, the principal investigators obtained measurements on the lake surface and the atmospheric boundary layer to study the modification of the air by Lake Ontario and the exchange of energy between the lake and the atmosphere.

Measurements were obtained during some of the alert periods with sensors mounted on buoys, a barge, towers on the lake and on land, instrument shelters, pilot balloons, tethered balloons, and several aircraft. Numerous intercomparisons between aircraft and towers were successfully executed. During the October alert period, the RFF DC-6 aircraft flew prescribed triangular patterns over the rawinsonde observation sites to augment the Lake Meteorology Panel's data set.

A planning meeting was held the evening before each period to coordinate the various aircraft flights, intercomparisons, and observational programs.

A panel meeting was held on September 15, 1972, at the Canada Centre for Inland Waters to discuss the goals and achievements of the May, June, and August alert periods. According to the reports by the principal investigators, the data collection had been moderately successful although the range of atmospheric stability conditions had not been as large as desired.

The fifth and final alert period will take place in November.

Terrestrial Water Balance

During the last report period, emphasis continued to be placed on data collection and correlation of data to the various tasks under the Terrestrial Water Balance Panel. Based on Provisional Daily Discharge records furnished by the U.S. Geological Survey, first-cut estimates of monthly runoff from the United States land area were completed for April through August 1972. As final data become available, more accurate and complete estimates will be forthcoming.

Delays in receiving data and, in some cases, shortage of manpower have caused several tasks to be shelved temporarily. Included among these is evaluation of land precipitation, lake storage, and over-water precipitation. The last of these depends upon radar precipitation data being supplied by other investigators. It is anticipated that above- and below-ground storage will be combined into a single factor for inclusion in the land-water balance equation.

A first-cut estimate of lake evaporation was made for April, and the results were sent to panel chairmen, Steering Committee members, and program coordinators. As of this report, a revised estimate for April and first-cut estimates for May through July have been completed, meeting our goal of monthly lake evaporation estimates. Estimated evaporation, in inches, by the water balance technique is as follows: April, 0.4 (revised to reflect additional data); May, 0.6; June, 1.0; and July, 2.1.

Excellent progress was made in assessing the inflow-outflow term for Lake Ontario. Simultaneous flow measurements in the Lower Niagara River, in the St. Lawrence River near Iroquois Dam, and in the Oswegatchie River at Ogdensburg should produce desired results. Additional flow measurements at Massena Point for calibrating power plant discharges were completed and will be included in the evaluation of the outflow term.

Two tower gages, an additional shore gage and a pressure gage, were added to the initial network of 19 water level gages. Data have been receive regularly and are being tabulated and stored in anticipation of further analysis and correlation. When an optimum gage network is determined for the computation of the lake storage term, results will be tested in the Corps of Engineers lake levels model. Meteorological data obtained from the shallow water tower off Braddock Point and concurrent water level data from the tower and shoreline gages were used in a preliminary study to determine if high winds created a measureable slope in the water surface between tower and shore. Although results were inconclusive, further tests will be made to measure meteorological effects on water transfers across a large lake.

Lake Chemistry and Biology[7]

After a slow start, and some difficulties caused by Hurricane Agnes, the chemistry and biology program is progressing well. All biology and chemistry cruises aboard the *Researcher* have been completed on schedule. The U.S. investigators participating in the program met in June and September to review accomplishments and discuss requirements for completing all projects. It was recommended that additional cruises be undertaken in May and June 1973. A meeting of United States and Canadian investigators concerned with biological and chemical studies is scheduled for November in Niagara Falls, Ontario.

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[7]Nelson Thomas of EPA has replaced N. Jaworski as U.S. Panel Co-Chairman on the Biology-Chemistry Panel.

OPERATIONS AND DATA ACQUISITION SYSTEMS

Ship Operations

The two major IFYGL vessels, the NOAA ship *Researcher* and Cape Fear Technical Institute's *Advance II*, have since May 1 each week conducted lake temperature cruises using electrobathythermographs, biological-chemical cruises using a Rosette water sampler (the *Researcher*), benthic cruises using grab and core devices (the *Advance II*), and transect cruises for internal wave studies.

Continuous weather observations are recorded on magnetic tape each week However, there has been considerable downtime due to lack of spare instruments for the infrared and spectral radiometers. Downtime has also affected operation of the air temperature and dew-point devices, as well as the water surface temperature probes, and occasional problems have arisen with the wind sensors. Continuous lake surface chlorophyll measurements, EBT data, and continuous barometric pressure data have generally been very good. Dissolved oxygen versus depth information will need some interpretation. The DECCA navigation system has been excellent.

During all cruises, the Cape Fear Technical Institute (CFTI) students who operate the data acquisition systems aboard both ships, assisted by General Electric technicians, perform routine quality control checks on the incoming data. The first half of the field season required extensive training for these personnel, and other CFTI students aboard the *Advance II*, because assignments are made on a rotating basis, generally every 3 weeks. The Rochester Operations Officer and GE personnel, assisted at times by U.S. Coast Guard marine technicians and the Rochester Field Data Center, were responsible for the training program. The Environmental Protection Agency laboratory in Rochester, which is processing water and chlorophyll filter samples, has instructed *Researcher* survey technicians in some operations during the biological-chemical studies.

Based on both Canadian and U.S. standards, calibration arrangements for the shipboard IFYGL sensors have been tentatively scheduled. Individual investigators aboard both the *Researcher* and *Advance II* have collected considerable data in support of lake optical properties, benthos, zooplankton, phytoplankton, and water chemistry studies.

The Bureau of Sport Fisheries and Wildlife vessel *Kaho* completed her fish population studies October 26 and has returned to Lake Michigan. The Lake Survey's *Shenehon* expects to complete her current harbor studies program by November 29. The *C.A. Dambach* of the State University College of New York at Buffalo expects to finish her inshore biological-chemical studies December 8 and return to Youngstown. The Lake Survey vessel *Johnson* and the Coast Guard Cutter *Maple* have retrieved seven buoys as of mid-November and expect to have all the buoys removed by early December.

Rawinsonde System

Observations from the three U.S. rawinsonde stations, located at Lakeside Beach State Park, Sodus Point, and Stony Point, N.Y., began on September 16, 1972, and are scheduled to terminate on December 10, 1972. The stations have been operated by the 6th Weather Squadron, 5th Weather Wing, Air Weather Service, under the command of CMSgt. William Rummel, USAF. The Canadian stations, located at Confederation Park, Presqu'ile Park, and Scarborough, Ontario, have been operating on the same schedule under the control of A. Micelli, Atmospheric Environment Service, Canada.

A technical report covering the operational aspects of the system is being jointly prepared and should be available for publication in the spring of 1973. A condensed version of this report will be presented at the April 1973 meeting of the International Association for Great Lakes Research, and will be submitted for publication in the proceedings of that meeting.

The rawinsonde data should be available to participating scientists in late spring or early summer of 1973. Requests for further information concerning this matter should be addressed to the Cochairmen of the IFYGL Data Committee:

United States

Mr. D. Drury
U.S. IFYGL Data Center
D22, CEDDA
NOAA - EDS
U.S. Dept. Commerce
Washington, D.C. 20235

Phone: 202-343-6802

Canada

Dr. H.S. Weiler
Dept. of the Environment
Canada Centre for Inland Waters
P.O. Box 5050
Burlington, Ontario
Canada

Phone: 416-637-4292

Buoys, Towers and Land Stations

With the end of the navigation season, 14 of the TI stations have been removed from the lake. Retrieval of buoy 18 on October 11, 1972, established procedures for retrieving the remaining stations in accordance with the following schedule:

Station	Date
Buoy 15	October 31
Buoy 12	November 1
Buoy 13	November 1
Buoy 19	November 4
Buoy 20	November 4
Buoy 21	November 5
Buoy 14	November 17
Buoy 16	November 17
Buoy 17	November 18
Tower 24	October 31
Tower 23	November 6
Tower 27	November 16
Tower 26	November 21

The lake stations in the Rochester area were left to the last possible moment. The last intercomparisons between the *Advance II* and *Researcher*, and between the ships and lake stations, were conducted on November 16 and 17.

A government-contractor team will continue to operate the five land stations and the Galloo Island station through March 31, 1973.

Postcalibration activities are in full swing. The following calibrations will be done at Rochester Field Headquarters: all temperature sensors, including the thermistor chains from the buoys and towers and the EBT sensors; all pressure sensors; all current meters; all wind direction sensors; and all electronic systems. Plans call for at least six wind speed units to be calibrated in the University of Michigan tunnel; the remainder will be done in Rochester by an "intercompare-check" procedure. Arrangements are being worked out to have some of the radiometer sensors calibrated at Canada's Atmospheric Environment Service (AES), Downsview. Calibration of the dewpointer is still undetermined.

As these calibrations are completed, the system components will be shipped to the National Data Buoy Center, NOAA, at the Mississippi Test Facility, Bay St. Louis, Miss.

EPA Water Chemistry Laboratory

Between August 24 and November 2, 1972, the following 28,737 laboratory analyses were completed for IFYGL, bringing the grand total to 52,058:

Total organic carbon	2,838
Nitrogen-ammonia	4,739
Nitrogen nitrate-nitrite	4,739
Nitrogen, total Kjeldahl	3,656
Fluoride	4,741
Silicon dioxide	4,739
Sulfate	4,739
Phosphorus, total	4,140
Phosphorus, ortho	4,190
Phosphorus, total filtrable	1,088
Chloride	1,478
Chlorophyll	2,933
Calcium	1,217
Magnesium	1,217
Sodium	1,217
Potassium	1,217
Mercury	149
Copper	503
Nickel	503
Zinc	444
Manganese	445
Iron	445
Chromium	215
Cadmium	317
Lead	149

All have been submitted to the Rochester Field Headquarters data processing group for entry into STORET.

INTERCOMPARISON OF DATA ACQUISITION SYSTEMS

ON CANADIAN AND UNITED STATES VESSELS

For intercomparison of the acquisition systems on IFYGL vessels, simultaneous data sets were collected on September 18, 1972, on a number of these vessels. As during a similar event on August 17 (see IFYGL Bulletin No. 4), the intercomparison was conducted near the deepwater tower off Braddock Point, N.Y., and consisted of the acquisition of meteorological data by the vessels for comparison with similar data collected at the same time by the tower.

Six vessels, including the Canadian ship, *Martin Karlsen* and the U.S. vessels *Researcher, Advance II, C.A. Dambach, Shenehon,* and the Oswego T-boat, participated in the program. Water samples were also collected, and some chemical analyses were carried out aboard ship. Subsamples were sent to several laboratories for determination of the concentration of a number of chemical species.

The data obtained from this intercomparison as well as from the two previous ones are being analyzed. It is anticipated that a published report on the results will be available in the latter part of 1973. In the meantime, questions concerning the intercomparisons may be directed to Andrew Robertson, EMP-IFYGL, National Oceanic and Atmospheric Administration, Rockville, Md. 20852.

NOTES FROM THE DESK OF THE

U.S. COORDINATOR

With the observational phase of IFYGL winding down in March 1973, we have now arrived at a position where we can assess the operational efficiency of the major systems used. As a result, we are planning a series of technical reports covering solely the operational aspects of the U.S. ships, aircraft, weather radar, buoys, towers, land stations, and rawinsonde systems - the last being a joint effort with the Canadians.

These reports are intended to serve two purposes:

(1) To provide scientific investigators with descriptions of equipment used, with considerable detail as to procedures and techniques. This will allow an investigator to ascertain how the data he will eventually use were obtained.

(2) To give management and planning staffs a considered evaluation of the actual performance of the systems used versus that originally anticipated. Inherent in this process is a listing of unanticipated events - both positive and negative - that may aid decision makers of the future in selecting equipment for projects similar to IFYGL.

We plan to present abridged versions of these reports at the meeting of th International Association for Great Lakes Research at Sandusky, Ohio, April 18-19, 1973.

APPENDICES

Prepared by CCIW

APPENDIX 1 - ABBREVIATIONS

A-D	Analog to digital
AES	Atmospheric Environment Service, Environment Canada
AFC	Automatic frequency control
AOL	Atlantic Oceanographic Laboratory, Environment Canada
ART	Airborne radiation thermometer
Calib.	Calibrate
CCGS	Canadian Coast Guard Ship
CCIW	Canada Centre for Inland Waters, Environment Canada
CCRS	Canada Centre for Remote Sensing, Department of Energy, Mines and Resources
CEDDA	Center for Experimental Design and Data Analysis, NOAA
CHN	Chain
CNC	Canadian National Committee for the IHD
CSS	Canadian Survey Ship
CW	Continuous wave
CWS	Canadian Wildlife Service, Environment Canada
CEM	Center for the Environment and Man, Incorporated
DC	Direct current
Deg.	Degrees
EBT	Electronic bathythermograph
EP	Earth Physics, Department of Energy, Mines and Resources
EPA	Environmental Protection Agency
Est.	Establish
FTP	Fixed temperature profiler
GLSL	Great Lakes - St. Lawrence Study Office, Environment Canada
GMD	A balloon-borne atmospheric sounding system utilizing a ground located radio direction finder for winds
GRND	Ground
GSC	Geological Survey of Canada, Department of Energy, Mines and Resources
HS	Hydrologic Sciences Division, Environment Canada
IFYGL	International Field Year for the Great Lakes
IHD	International Hydrological Decade
Ins.	Install
IR	Infrared
JMT	Joint Management Team for IFYGL
JSC	Joint Steering Committee for IFYGL
LOA	Length overall
LOP	Line of position
Max.	Maximum

Met.	Meteorological
Min.	Minutes
Mon.	Monitor
MS (MSB)	Marine Sciences Branch, Environment Canada
MV	Motor Vessel
NASA	National Aeronautics and Space Administration
NC	National Committee of the IHD
NCAR	National Center for Atmospheric Research
NM	National Museum of Canada
NOAA	National Oceanic and Atmospheric Administration
NOIC	National Oceanographic Instrumentation Center
NRCC or NRC	National Research Council of Canada
NY	New York
NYDEC	New York State Department of Environmental Conservation
ODLF	(Provincial) Ontario Department of Lands and Forests (now OMNR)
OME	(Provincial) Ontario Ministry of the Environment
OMNR	(Provincial) Ontario Ministry of Natural Resources
Ont.	Ontario
OOPS	Ontario Organic Particle Study (CCIW project)
OWRC	(Provincial) Ontario Water Resources Commission (now OME)
PPS	Pulses per second
PPI	Plan Position Indicator
PTH	Pressure, Temperature, Humidity
RFF	(U.S.) Research Flight Facility of NOAA
RH	Relative Humidity
RHI	Range-height indicator
RMS	Root mean square
rpm	Revolutions per minute
R.V.	Research Vessel
RX	Radio receiver
SAM	Sensor Acquisition Module
SCOR	Special Committee for Oceanographic Research
S.D	Standard deviation
Sec.	Seconds
SI	Système International de Unites
TID	Temperature/depth
temp.	Temperature
TTP	Towed Temperature profiler
TX	Radio transmitter
UNESCO	United Nations Educational, Scientific and Cultural Organization
U of T	University of Toronto
USBSFW	United States Bureau of Sports Fisheries and Wildlife

USLS	United States Lake Survey
UTM	Universal Transverse Mercator
VHF	Very high frequency
VIP	Video integrator and processor
WSC	Water Survey of Canada, Environment Canada

APPENDIX 2 - INDEX OF PARTICIPANTS (VOLS. 1 - 4)

APPENDIX 3

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